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STUDIES ON THE AVIAN SPECIES OF THE CESTODE FAMILY HYMENOLEPIDIDAE

WITH 9 PLATES AND 2 TEXTFIGURES

BY

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Contributions from the
Zoological Laboratory of the University of Illinois
under the direction of Henry B. Ward
No. 260

THESIS

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INTRODUCTION

The internal parasites of American birds are little understood, and it was with the idea of finding out something about the species of cestodes and extent of the infections that the investigations herein reported were undertaken. A considerable quantity of material was obtained from the collection of Professor H. B. Ward, who very kindly allowed me to use it. In order to augment this and to secure fresh material, the examination of as large a number of additional hosts as possible was undertaken. While attending the session of the University of Washington Biological Station in the summer of 1923, 45 birds obtained in the region of Friday Harbor, Washington, were examined. A total of 537 hosts has been examined. There were 60 different species among these, and of this number 40 were found to be infected with cestodes. More than half of the specimens of 31 of the species were found to be infected. Since a comparatively small number of some of the host species was obtained, a further analysis of the records would be of little value at present.

As mounts were prepared for a preliminary determination, it was observed that a considerable number of species belonging to the genus Hymenolepis Weinland 1858 had been obtained, and they were accordingly brought together for further study. That a comparative study of the family Hymenolepididae, and especially of the genus Hymenolepis would be an important contribution to the existing knowledge of this group, was evidenced by an examination of the literature. The numerous papers examined disclosed descriptions of about 160 species which had been assigned to the genus Hymenolepis, and that, beyond the comparisons made by Fuhrmann, Cohn, Clerc, and Wolffhügel, no extensive comparative study of the genus had been undertaken. The conclusions herein set forth are the result of a detailed study largely from the literature of each of the species assigned to the genus Hymenolepis, and of the twelve new species of which material has been obtained. But five North American species have been reported exclusive of those imperfectly described by Leidy (1887).

I wish to express my appreciation for the very helpful suggestions which Professor Ward has given during the progress of the work, for the use of his extensive library, and for the loan of specimens from his collection. Thanks are due to Professor Frank Smith for the identification of a number of the hosts, and to Professor T. C. Frye, Director of the University of Washington Marine Station, for his interest and assistance in securing the hosts for examination at Friday Harbor, Washington.

METHODS OF TECHNIQUE

At the beginning a number of killing fluids were tried, with the uniform result that acid fluids, such as Gilson's and Petrunkevitsch, react with the calcareous bodies with such violence that large cavities resulted in the preserved worm or the proglottids are puffed out balloon-like by the gas formed within. The most satisfactory killing fluid was found to be a saturated solution of corrosive sublimate in distilled water. This is allowed to act from one to two hours, and replaced by 50 per cent alcohol for one hour, then 70 and 85 per cent alcohol. Great care must be exercised to extract all the corrosive sublimate before staining and mounting, as it interferes with clearing. An effort should be made to secure the worms as fully extended as possible, which may be done by gently pulling them with the fingers protected by rubber gloves or by Looss' (1901) shaking method.

The stain used for toto mounts and sections was in most cases Ehrlich's acid hematoxylin, although Delafield's and Conklin's modified hematoxylin were also about equally satisfactory. The procedure followed was to use Ehrlich's acid hematoxylin full strength, staining in toto for two to four days depending on the size of the worms, rinse off the stain with 50 per cent alcohol, and destain in 10 per cent HCl. The length of time to be allowed for destaining varies with the size of the specimen and can only be determined by practice, but usually only a few seconds or one minute is necessary. The acid is neutralized by a saturated solution of Na_2CO_3 in 70 per cent alcohol. The stain is improved by allowing the stock solution to concentrate through evaporation down to a very dark color and this may be used over and over by first filtering to insure the removal of any sediment. The object of the process was to get the largest amount of stain possible into the internal organs, and then to remove as much as possible from the overlying tissues which retain it less strongly than do the reproductive organs. Specimens stained and prepared in this manner were cleared, the desired number of proglottids removed from the selected regions for sectioning and the remainder mounted as totos. Specimens to be sectioned should not have quite as much stain removed as those for toto mounts, but the remaining pieces may be further destained for mounting as totos if found to contain too much. Sections thus stained and sectioned may be counterstained with eosin. The counterstain gives the most satisfactory results if rather heavy since the ducts, as vasa deferentia, take it up readily, and, unless too heavy, it does not obscure the other structures. A small outline of the pieces of the cestodes from which proglottids had been removed for sectioning was found very useful. These are conveniently made on small cards the size of the slides, and may be placed behind the slides in the boxes. They are useful also for recording data as to length, width, etc., as well as to show readily the position of the portions sectioned.

HISTORICAL ACCOUNT OF THE FAMILY HYMENOLEPIDIDAE

The name Hymenolepidae was first used by Ariola (1899), and he defines the genus as follows: "con corpo di media o minima grandezza, e scolice armato di una o piu corone di piccoli uncini." There is no list of genera or discussion of its limits. The name Hymenolepididae was used by Railliet and Henry (1909) and is synonymous with Hymenolepidae, Echinocotylidae, and Dilepinidae, according to Ransom (1909) who gives the following diagnosis:

"Taenioidea: Scolex with an armed rostellum, or without rostellum. Hooks on the rostellum not hammer-shaped. Suckers usually unarmed. A single, or rarely, a double, set of reproductive organs in each segment. Genital pores marginal and bilateral, unilateral, or regularly or irregularly alternate. Eggs with thin transparent shells. Adults in mammals, birds, reptiles, and Amphibia."

Under this family he includes the following subfamilies and genera:

Dipylidiinae Stiles 1896

Dilepis Weinland 1858
Trichocephaloides Sinitsin 1896
Lateriporus Fuhrmann 1907
Choanotaenia Railliet 1896
Monopylidium Fuhrmann 1899
Anomotaenia Cohn 1900
Amoebotaenia Cohn 1899
Liga Weinland 1857
Leptotaenia Cohn 1901
Parvirostrum Fuhrmann 1907
Cyclustera Fuhrmann 1901
Laterotaenia Fuhrmann 1906
Proorchida Fuhrmann 1907
Cyclorchida Fuhrmann 1907
Gryporhynchus Nordmann 1832
Angularia Clerc 1906
Catenotaenia Janicki 1904
Dipylidium Leuckart 1863
Oochoristica Lühe 1898
Pancerina Fuhrmann 1899

Paruterininae

Paruterina Fuhrmann 1906
Culcitella Fuhrmann 1906
Rhabdometra Kholodkovski 1906
Anonchotaenia Cohn 1900
Metroliasthes Ransom 1900
Biuterina Fuhrmann 1902
Nematotaenia Lühe 1899
Stilesia Railliet 1893

Hymenolepidinae

Oligorchis Fuhrmann 1906
Hymenolepis Weinland 1858
Subgenus Hymenolepis Weinland 1858
Subgenus Echinocotyle Blanchard 1891
Diorchis Clerc 1903
Haploparaxis Clerc 1903

The above list gives some idea of the size of the group. That it is a poorly defined group is indicated by the lack of any statement of well marked characters in the family diagnosis. It is best to consider briefly the scolex and its hooks in a few genera in order to see the great variety of types that are to be found. Dilepis has a double crown of hooks as do Monopylidium, Anomotaenia, Liga, Parvirostrum, and five other genera. Nine genera are defined as having a single crown of hooks and seven are unarmed, while Angularia is stated to have "a zigzag crown of numerous hooks (about 50)" and Dipylidium several rings of rose thorn hooks. Almost every possible combination of pore arrangement with reference to the margin and of the genital ducts to the excretory ducts is found. In Dilepis the pores are unilateral and the ducts pass dorsal to the excretory vessels and nerve, in Choanotaenia the pores are irregularly alternate and the ducts pass between the excretory vessels and dorsal to the nerve, in Liga the pores are regularly alternate and the ducts pass dorsal to the excretory vessels and nerve, in Cyclorchida the pores are unilateral and the ducts pass between the excretory vessels, Diplidium has a pore on each side and a double set of reproductive organs, and in Anonchotaenia the pores are irregularly or regularly alternate and the ducts pass ventral to the excretory vessels and nerve. The number of testes varies from one to 50 in the different genera. The shape of the hooks differentiates the family from the Davaineidae as defined by Ransom, but on the other hand some species of Hymenolepis have hooks much like those of the Taeniidae, and moreover, according to Ransom's statement, they may be anything but hammer-shaped. The character of the uterus is not diagnostic since the genus Catenotaenia is described as having a uterus consisting of a median stem and lateral branches which is like that in Taeniidae.

Fuhrmann (1907) gives a classification from which two or three quotations are now made:

"IV Familie Davaineidae

"Scolex mit einfach gebautem Rostellum, das mit einem doppelten Kranz sehr zahlreicher, meist sehr kleiner hammerförmiger Haken bewaffnet ist. Genitalorgane einfach oder doppelt, Genitalpori beiderseitig, einseitig oder unregelmässig abswechselnd.

"V Dilepinidae

"Scolex mit oder selten ohne bewaffnetes Rostellum, Saugnäpfe unbewaffnet. Genitalpori beiderseitig, einseitig, regelmässig abwechselnd. Genitalorgane selten verdoppelt, meist einfach.

"VI Hymenolepinidae

"Scolex meist bewaffnet mit einem einfachen Kranz von Haken, selten ohne oder mit nur rudimentärem Rostellum. Gleider immer breiter als lang, Genitalporen münden einseitig; die Geschlechtsgänge gehen über die bieden Langsstämme des Wasserfässsystem und den Längsnerven

durch. Die Hoden in der Zahl von 1 - 4. Vas deferens immer kurz, mit Samenblase, Uterus sackförmig, Eier mit drei Hüllen. In Säugetieren und Vögeln.

Fuhrmann (1908) places in the family Hymenolepididae the genera Oligorchis, Hymenolepis (recognizing the subgenus Echinocotyle), Diorchis and Aploparaksis. It is to be noted that the family Hymenolepididae is the most sharply defined of the three referred to above which include those genera which have been grouped more or less together by Ransom and by Braun (1894-1900). The family Davaineidae is fairly well defined by the character of the hooks and their arrangement, while the family Dilepinidae contains a large group of genera differing rather widely in some respects, the most outstanding difference being in the character of the reproductive organs which may be either double or single in a prolgottid. Braun (1894-1900) gives a classification which is upon less natural lines as is evidenced when the following points are mentioned: Hymenolepis, (recognizing the subgenus Drepanidotaenia) Choanotaenia, and Dipylidium are placed in the subfamily Dipylidiinae with a number of others, and Davainea, Echinocotyle and Fimbriaria in the subfamily Davainiinae.

The genera which were placed in the family Hymenolepididae by Fuhrmann (1907) are Oligorchis Fuhrmann (1906a) Hymenolepis Weinland 1858, Diorchis Clerc 1903, and Aploparaksis Clerc 1803. A discussion of the historical data relating to these genera is given in the following pages.

HISTORICAL ACCOUNT OF THE GENERA

GENUS OLIGORCHIS FUHRMANN 1906

Fuhrmann (1906a: 217) describes the type species of this genus under the name of *O. strangulatus*. The material was taken from *Elanoides purcatus* (L.) and was collected in Brazil. It is well described, and, since a discussion of its structure and a diagnosis of the genus is given in the systematic portion of this report, any further details seem unnecessary at this point.

GENUS HYMENOLEPIS WEINLAND 1858

This is the oldest genus belonging to the family and has had about fifteen times as many species assigned to it as to Haploparaksis Clerc 1903, which is the next largest in size. Since an extended study of the species assigned to it has been made, it is proper to trace rather fully its history, especially the points which are concerned in the present study.

The genus was first described by Weinland in 1858 as a result of his study of a number of pieces of a small tapeworm received from the collection of the Medical Improvement Society of Boston. The specimens were from an infant 19 months old, and had been obtained in 1842. Since the publication is rather inaccessible and since some very important characteristics are pointed out, it seems advisable to refer to the details which Weinland mentions at some length at this point. It was preserved in the collection of the society under the name of "*Bothriocephalus latus*," probably owing to the regularity and shortness of the joints. "Moreover, there is a yellowish spot, clearly visible to the naked eye, situated about the middle of each joint, which reminds us very much of the color and situation of the genital organs as known in Bothriocephalus," according to the account of Weinland.

"A careful examination, however, has taught us that there were in that phial parts of at least six different specimens of a very characteristic tapeworm, belonging neither to the genus Bothriocephalus nor to the genuine Taeniae,—which latter, when limited in our sense, comprehend, besides *Taenia solium*, only tapeworms of carnivorous mammals,—but to a group of Taenoids, whose members thus far had only been found in small omnivorous or insectivorous Mammalia (mice, shrew-mice, etc.) and birds. It is widely different from *Taenia solium*, and its true congeners, in the structure of its eggs, the situation of its genital openings, etc."

After a somewhat extended description of the external characters such as measurements, shape of proglottids, Weinland discusses the reproductive

organs as follows: "In relation to the genital organs, we have mentioned above the yellowish spots lying near the middle line in the anterior part of each joint, and it is for this that we have called the species *flavopunctata*. These spots are the testicles, appearing under the microscope as a globular gland, with another small one attached to it; this latter one runs out, toward the side of the joint into a long slender canal, in which lies the penis. The genital openings are situated all on one and the same side of the worm, while in all true taenias known thus far, they are found irregularly, now on one, now on the other side. The configuration of the uterus, also, differs greatly from that in the genuine Taenias. There is no main-stem in the midst with lateral branches, as in the latter; but, on the contrary, the eggs are crowded over the whole joint. It sometimes appears as if they were arranged in straight lines along the joint; but this is certainly owing only to the regular lines of muscular contractions. Only fresh specimens can decide ultimately the structure of the uterus. From a careful dissection of the younger joints, we should judge that it consists of globular blind sacs, located here and there in the joint, and connected by fine tubes terminating finally in the vagina. The most characteristic feature of this worm is its eggs, the number of which may be counted by thousands in each ripe joint. They are very large, measuring .054 millim. in diameter, and under a low power of the microscope appear as transparent balls with a yellow dot in them. With a higher power, we easily distinguish three distinct eggshells (Fig. 9, 1, a, b, c). The outside shell is translucent, elastic, cracking in sharp angles under pressure and only .0007 millim. thick; this shell is folded by application of glycerine. The second shell is membranaceous and irregularly wrinkled, thinner than the first, and immediately attached to it..... The large cavity which is formed by these two outside shells contains a fluid, in which swims the small globular embryo (measuring only 0.024 millim.), enclosed in a third shell, closely attached to it, but of considerable thickness (0.001 millim.). We cannot state with certainty that there are three pairs of spines to this embryo; if there are any, they must be very small."

It is interesting to note that Weinland points out as characteristics of the genus some which seem to be of almost universal occurrence in the species assigned to it at the present time, namely, three egg shells, unilateral genital pores, and a transverse sacular uterus. In all the descriptions of the species the only suggestion that there are but two shells is by Ransom (1909), in his account of *H. cantaniana* which reads as follows: "When they first enter the uterus, the eggs have but a single thin membrane and measure but 20μ in diameter. Later other membranes are developed, and the egg (Fig. 29) in the final stage of development possesses two well-defined shells, an inner one 27 to 35μ in diameter and an outer one 45 to 60μ in diameter. Between the outer and inner shell is an intermediate

finely granular layer limited by a very thin membrane internally and externally." That this "very thin membrane" is the third shell or the rudiment of it seems not at all improbable.

Concerning unilateral genital pores, the following species may be referred to. *Weinlandia asymetrica* Fuhrmann 1918 is described as follows: "nous avons observé que les pores sexuels qui sont unilatéraux peuvent se trouver, de temps en temps, mais très rarement, sur le côté opposé." Another observation is noted in *Weinlandia lateralis* in this report. Such irregularities may be referred back to the ancestral condition of this very large group of cestodes in which the position of the pores was probably irregularly alternate. Concerning the structure of the uterus, the only exception to the transverse sacular type that has been found is that of *H. pauciovata* Fuhrmann 1906, in which it is spherical in shape and centrally located in the proglottid.

Weinland gives a proposed revision of the taenoid cestodes in a footnote beginning on page 50, which is based primarily on the eggshell. It is briefly outlined as follows:

Family Taenioidea; 4 suckers on the head and with marginal genital openings.

Subfamily Sclerolepidota "with a hard, brittle, rather thick, and dark colored eggshell."

Genus 1. Taenia, uterus with median stem with lateral branches, head with two rows of hooks of the type of *T. solium.*

Genus 2. Acanthotrias Weinl. 1858 with three rows of hooks, type *Cysticercus acanthotrias* which Weinland described on page 64 of the same paper.

Genus. 3. Taeniarhynchus, Weinl. type *T. mediocanellata*, without rostellum.

Genus 4. Echinococcifer Weinl. here belongs, *T. echinococcus.*

Genus 5. Diplocanthus Weinl. with a crown of bifid hooklets.

Subfamily Malacolepidota (Soft shelled tapeworms, shell thin and transparent).

Genus 1. Hymenolepis Weinl. The name is derived from the Greek words meaning membrane and shell. "Rarely 2 rows of hooklets on the proboscis." Uterus consisting of ball-like blind sacs.

Subgenus Lepidotrias Weinl. with three eggshells, type *T. murina* Dujardin.

Subgenus Dilepis Weinl. with two eggshells. Type *T. angulata.*

Genus 2. Proteocephalus Weinl. No proboscis nor hooklets, eggs with 2 shells, head very changeable in shape. Type *T. ambigua* Dujardin.

Genus 3. Alyselminthus Zeder, containing only *T. cucumerina* of the dog, small spines arranged in a series of rows.

Since a discussion of the synonomy of most of the above divisions is given by Stiles (1903), it does not seem advisable to go into the details here, but since this study is especially concerned with the genus Hymenolepis, and its particular type of structure in order to determine which of the proposed new genera shall retain this name, I must now go into this somewhat in detail.

Grassi (1888) points out the synonomy of *Taenia diminuta* Rudolphi 1819, *T. leptocephala* 1825, and *H. flavopunctata* Weinland 1858. R. Blanchard (1891) gives a description of the anatomy of *H. diminuta* based on the work of Grassi (1888)Zschokke (1885-88) and recognizes the genus Hymenolepis Weinland. The important characters which distinguish it are stated as follows:

"Corps petit, filiforme. Tête petite, pourvue d'un rostre réctractile, bien développé et armé d'une simple couronne de 24 à 30 petits crochets, ou rudimentaire et inerme. Cou long. Anneaux en dents de scie, beaucoup plus larges que longs, en nombre rarement inférieur à 150. Pores sexuels marginaux, percés sur le bord gauche des anneaux, la face ventrale de ceux-ci étant celle qu'occupe l'appareil génital femalle. Appareil mâle formé d'un très petit nombre de testicules, le plus souvent de trois, dont deux dans la moitié droite et un dans la moitié gauche de l'anneau. Anneau mûr transformé en un sac plein d'oeufs clairs, arrondis ou oblongs, et entourés de trois coques très écartées les unes des autres. La coque interne enserre l'oncosphère et n'a pas d'appareil pyriforme; elle présente parfois un mamelon à chaque pôle. La larve est un *Cryptocystis* ou un *Staphylocystis*. La migration s'accomplit soit entre deux organes d'un hôte unique, soit, le plus souvent, entre deux hôtes différents, l'hôte intermédiaire étant un Insects ou un Myriapode."

Blanchard placed in this genus 14 species giving a short diagnosis of each. These species are the following:

First Group—Armed Hymenolepis

H. murina Dujardin 1845	*H. pistillum* Dujardin 1845
H. nana von Siebold 1853	*H. tiara* Dujardin 1845
H. microstoma Dujardin 1845	*H. erinacei* Gmelin 1845
H. furcata Stieda 1862	*H. bacillaris* Goeze 1782
H. uncinata Stieda 1862	*H. acuta* Rudolphi 1819
H. scalaris Dujardin 1845	*H. decipiens* Diesing 1850

Second Group—Unarmed Hymenolepis

H. relicta Zschokke 1888	*H. diminuta* Rudolphi 1819

Thus the genus Hymenolepis was established. The genus grew by investigators referring previously described species to it, or by placing new ones in it until it has reached the present great size of about 200 species. The species found in birds have been brought together by the following investigators. Fuhrmann (1908) has the most extensive list thus far

published. It contains about 125 species listed under the host orders and again by hosts. Ransom (1909) catalogues the names of about 70 species with their hosts and references to the most satisfactory descriptions.

The literature dealing with this large collection of species is indeed anything but satisfactory since no extensive attempt has been made to assemble the important characters of the various groups of species and to determine what are the relative value of these characters. One may identify a cestode belonging to this genus only in one of the following ways. He may look up the descriptions of as many species as are available, compare the size, number and shape of hooks, arrangement of the testes, and other internal organs with those structures on his specimens or he may take one of the host lists, and look up the species described from the host from which his specimens were obtained. The process by either method is time-consuming and the result likely to be unsatisfactory because of the lack of sufficient details in many of the descriptions. The proposed grouping of the species incorporated in this report is a result of a comparative study of the descriptions of all the species and of the new species herein described from North American birds.

CHARACTERS PREVIOUSLY USED TO DIVIDE THE GENUS

The divisions of the genus Hymenolepis which have not yet been discussed have been made upon the character of the hooks. The division based upon the characters of the egg which was advocated by Weinland (1858) has been discussed above. Railliet (1892) proposed a grouping of the numerous species of cestodes of birds in particular into the two genera of Drepanidotaenia and Dicranotaenia. At the end of a note in this paper, which deals with some specimens of *Taenia tenuirostris* Rud., he defines these proposed new genera and remarks as follows:

"Puisque l'occasion se présente de parler des Ténias des Oiseaux, je tiens à signaler en passant la necéssité de poursuivre la division de ce groupe, entreprise déjà par R. Blanchard. Il est impossible, en effet, de laisser parmi les Taenia s. str., c'est-à-dire à côté des grands Ténias de l'Homme et des Mammifères, l'ensemble des Téniadés qui vivent dans l'intestin des Oiseaux.

"Aussi proposerai-je d'établir pour ceux-ci deux nouveaux genres, basés principalement sur la forme des crochets:

1. Drepanidotaenia, pour les Téniadés du type *Taenia lanceolata* Bloch, dont le rostre est armé d'une couronne simple de crochets uniformes, généralement en petit nombre, a manche beaucoup plus long que la garde, qui est toujours faible.

2. Dicranotaenia, pour ceux du type *Taenia coronula* Dujardin, qui ont une couronne simple de crochets uniformes, courts, généralement en petit nombre, à garde égalant ou supassant également le manche en longueur, et formant avec la lame une sorte de petite fourche.

"Plusieurs autres divisions semblables devront être effectuées par la suite, mais j'ai visé principalement ici les Téniadés des Oiseaux domestiques, les seuls dont j'aie pu jusqu'à present m'occuper d'une façon suivie."

Railliet gives no list and mentions no species other than those named as the types. Stiles (1896) recognizes the above genera and groups several species under each with diagnoses of each and a key. The difficulties which are encountered when an attempt is made to use the above characters as distinctive of genera are very evident in Stiles' classification. He includes in the genus Dicranotaenia *Amoebotaenia cuneata* Linstow 1872 (=*Dicranotaenia sphenoides*) which has 15 to 20 testes and alternating genital pores. Along with the above species he includes *H. coronula* Dujardin 1845, *H. aequabilis* Rud. 1809 and *H. furcigera* (Krabbe) 1869. In the genus Drepanidotaenia, Stiles places *Monopylidium infundibulum* (Bloch) 1779, which is like *Amoebotaenia cuneata* in that it has numerous testes. Here also are placed *H. tenuirostris* (Rud.) 1819, *H. setigera* (Frölich) 1789, *H. collaris* (Batsch) 1786, (=*H. sinuosa* Zeder 1800), *H. anatina* (Krabbe) 1869, *H. lanceolata* (Bloch) 1782, *H. fasciculata* Ransom 1909 (=*H. fasciata* Rud.) 1809, and *H. gracilis* (Zeder) 1803. It is seen by the classification outlined above that much difficulty is encountered in bringing such widely different forms into the same genera. An interesting note is found in the addendum, (p. 60) of Stiles (1896) as follows:

"Choanotaenia: Railliet proposes a new genus, with *Taenia infundibuliformis* Goeze as type in the following words: Le *Taenia infundibuliformis* Goeze, que j'avais placé provisoirement dans le genre Drepanidotaenia, s'en distingue par le grande nombre des testicules, et d'une manière générale par la constitution de l'appareil reproducteur (Crety). Il mérite donc de devenir le type d'un nouveau genre Choanotaenia. *Ch. infundibuliformis*, intestin de la poule."

"Although I recognize the great difference in organization between *T. infundibuliformis* (as described by Crety) and the other species of Taenia which have been placed in Drepanidotaenia, and am inclined to consider it generically distinct from these worms (see p. 45), and although I have the highest regard for the opinion of my colleague and for his keen foresight, particularly in systematic questions, I prefer to reserve judgment upon his new genus until its type species and a few allied forms are more thoroughly understood, especially as it appears to me that *T. infundibuliformis* as determined by various authors is rather a heterogeneous and collective species."

Thus it is apparent that uncertainty was at once present in the minds of the first workers in these new groupings as to the importance of the characters which they had assigned to them, when they made comparisons with the internal structures.

Cohn (1901) divided the genus Hymenolepis into the subgenera Hymenolepis, which contained those species with more than ten hooks or with

rostellum rudimentary and unarmed, and Drepanidotaenia, which included those with eight to ten hooks. Neither of the above subdivisions have come into general use due to the difficulty of accurately dividing a group of species on the basis of the number of hooks or their shape. The difficulty is very real when the shape is used since there are all grades of intermediate forms between the two extremes, and such a system would be mathematical, a very unsatisfactory method due to the differences in position in which different observers might select in which to view the hooks, and the errors of measurements of different investigators. It also happens in many cases that the scolex is not obtained or it may not be possible to count the hooks or to observe their shape accurately, due to the state of contraction of the rostellum. If, in such a case, the scolex is sectioned, there is always the possibility that hooks may be torn off by the knife or cut into pieces, leading to an unreliable count and view of the shape. It is not infrequent also that individual hooks are lost, and, if this happens, the fact is sometimes difficult to detect from the position of the remainder. A very striking illustration of the slight value which may be placed upon the characters of the hooks aside from the internal structures is found in *Weinlandia introversa* and *Weinlandia macrostrobilodes*. It is noted in the descriptions of these forms that the hooks are almost identical in shape, so similar in fact that one might easily interpret any discrepancies to inability to obtain a proper view; the hooks are also very near to each other in size (*W. macrostrobilodes* 15 to 16μ, and *W. introversa* 17 to 20μ) and number.

Moreover, the arrangement and general structure of the internal organs are almost identical except for the differences in size recorded in detail in the description of *W. introversa*. There are two very outstanding differences, however, which separate these two species very widely from each other. These are the differences in the rostellum, which in *W. introversa* it is an introvert, and in *W. macrostrobilodes* is retracted as a solid muscular organ, and the difference in the size of the internal organs and of the strobila for the details of which the reader is referred to the descriptions of the species.

A little discussion of the manner of retraction of the rostellum seems proper at this point. It would appear that if the characteristic difference between the muscular arrangement of the rostellum which results in this organ being retracted as an introvert in the one case, and as a solid muscular organ in the other, had been observed by former investigators, they would have attached as much importance to it as they did to the number and shape of the hooks. The differences in the muscular arrangement are indeed marked as is apparent when figures 63 and 72 are compared. Yet this difference was not fully established until sections were studied; thereafter the arrangement could be made out in properly prepared toto mounts.

Another subdivision of the genus Hymenolepis remains to be discussed. Blanchard (1891) groups the cestodes with armed suckers into three genera, namely: Echinocotyle R. Blanchard 1891, Davainea R. Blanchard and Railliet 1891, and Ophryocotyle St. Friis 1870. The genus Echinocotyle was based upon the anatomy of *Echinocotyle rosseteri*, the internal antomy of which is imperfectly known, but which had the suckers armed with three series of hooks. But one species was placed in this genus by R. Blanchard; later Fuhrmann (1908) included four others besides the type mentioned above and considered it as only a subgenus. The value of such an external character, however, seems to be of little importance.

In connection with the study of the scolex and other external features as systematic characters, it is interesting to note the conclusions arrived at by Fuhrmann (1918) as a result of his studies on the anatomy of *Fimbriaria intermedia* Fuhrmann 1914 and *F. fasciolaris* (Pallas 1781). The relative importance of the pseudoscolex as compared with the internal structures as a systematic character is very fully considered, and the conclusion is reached that it is of only secondary importance and that the genus should be placed in the family Hymenolepididae.

Concerning comparative studies upon the species assigned to the genus Hymenolepis, there seems to be few of any importance because of their limited range. Fuhrmann (1906d) compares the hooks as to number and shape in a considerable number of species. On page 625 he gives a diagram showing the relationships between the different shapes, and mentions a number of species in connection with each type. He also discusses in a general way the scolex, excretory system, musculature, and cirrus sac. Fuhrmann (1906e) compares the reproductive organs of a limited number of species by taking into account the relative position of the testes to each other and to the ovary. He defines nine groups which may be described as follows, using the letters designating his figures:

a,—two testes posterior and one anterior and median to both posterior organs, typical species *H. megalorchis* Lühe 1898, *H. microps* (Dies.) 1850, *H. coronula* (Duj.) 1845, *H. filirostris* Wedl. 1856.

b,—arrangement like above but anterior testis in front of antiporal posterior, no typical species named.

c,—arrangement a, except anterior testis is lateral to antiporal posterior testis, typical species *H. farciminalis* (Batsch) 1786, *H. interrupta* (Rud.) 1809, *H. longirostris* (Rud) 1809, *H. megalops* (Nitzsch) 1829, *H. gracilis* (Zeder) 1803.

d,—two testes antiporal and one poral to the ovary, in a transverse row, typical species *H. bisaccata* Fuhrmann, *H. micrancristrota* (Wedl).

d_1,—testes like above but lateral ones outside excretory ducts, typical species, *H. multiformis*.

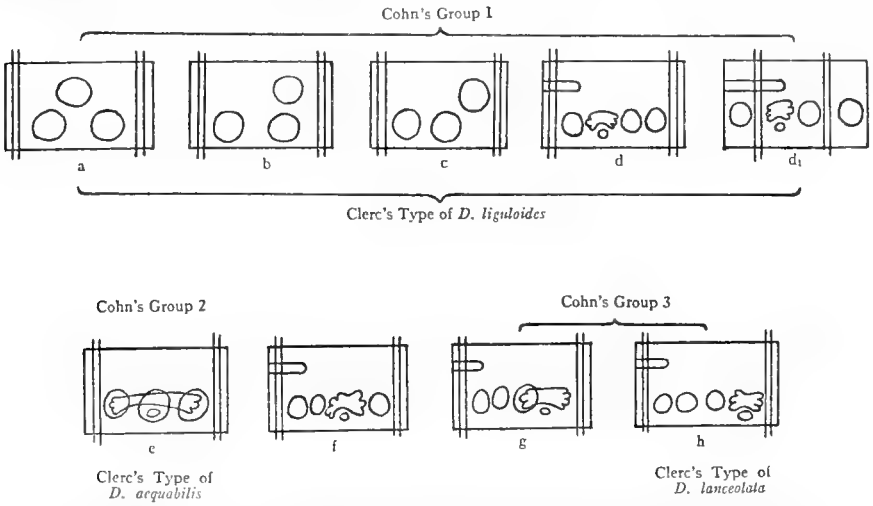
e,—testes like d, but the middle one dorsal to the ovary, typical of *H. himantopodis* (Krabbe), *H. fragilis* (Krabbe), *H. villosa* (Bloch), *H. aequabilis* (Rud.), *H. tenuirostris* (Rud.), *H. breviannulata* Fuhrmann, and *H. microscolecina* Fuhrmann.

f,—two testes poral to ovary and other antiporal, typical of *H. brachycephala*.

g,—all three testes poral to ovary but antiporal one dorsal to ovary, typical of *H. setigera* (Fröhlich), *H. unilateralis* (Rud.) Fuhrmann, *H. elongata* Fuhrmann.

h,—all three testes entirely on the poral side of the ovary, typical species *H. lanceolata* (Goeze).

The difficulty in using the above groupings arises in placing the ovary correctly for there are all degrees of variation between some of them, as illustrations of which we may mention *H. pauciovata* Fuhrmann 1906, *H. serrata* Fuhrmann 1906, *H. bilateralis* v. Linstow 1905, and others in which the ovary extends beneath the testes, it often being necessary to use the shell gland or vitelline gland instead of the ovary as the point of decision. While there is some value to the above grouping there is less regularity and it is less clearly defined than when the relative position of the testes is used as a criterion.



TEXTFIGURE 1. DIAGRAM SHOWING THE RELATION BETWEEN THE GROUPINGS OF SPECIES OF HYMENOLEPIS MADE BY FUHRMANN, COHN AND CLERC
(The figures are after the patterns made by Fuhrmann)

Clerc (1903: 308) distinguishes three types of testicular arrangement, based partly upon other observers' work in the subgenus Drepanidotaenia which he designates as follows:

a,—type of *D. liguloides*. "Le premier type a été déjà décrit par Cohn. Il est caractéristique pour les espèces à proglottis relativement long, ce qui permet à un des testicules de se loger en avant de l'autre."

b,—type of *D. lanceolata*, "établi par Wolffhügel et par Cohn, ne renferme que deux espèces, *D. lanceolata* et *setigera*, que j'ai décrites plus haut. Il est caractérisé avant tout par le fait que les glandes femelles sont très peu volumineuses et entièrement logées dans la moitié du proglottis opposée au pore génital. Les testicules sont, par contre, très volumineux et disposés suivant une ligne transversale."

c,—type *D. aequabilis*, "comme les deux types précédents, caractérisé par un très grand développement des testicules, mais il en diffère par la position et les dimensions des glandes femelles. Ces dernières sont médianes, rigoureusement ventrales et occupent souvent tout le champ ventral du proglottis, entre les vaisseux excréteurs."

Cohn (1904) in a footnote (p. 244, 245) discusses the arrangement made by Clerc and described above, and defines these three groups as follows:

1. Hoden inkongruent, einer proximal, zwei distal. Weibliche Drüsen wenig in die Breite entwickelt, mehr-weniger median.
2. Alle drei Hoden auf einer Seite, während die weiblichen Drüsen auf der anderen Seite liegen.
3. Hoden kongruent, einer median. Weibliche Drüsen stark in die Breite entwickelt.

This, it is seen, is but little different from that outlined by Clerc except that the ovary enters into all three, while Clerc leaves it out of account in the *D. liguloides* type. The diagram in textfigure 1 indicates the relationships between these three suggested groupings.

GENUS DIORCHIS CLERC 1903

This genus is relatively young and consequently one finds few historical data. It was established by Clerc (1903: 281) with *D. acuminata* as the type. He defined its characters as follows:

"Cestodes d'oiseaux à proglottis très nombreux et courts. Crochets du rostellum en petit nombre et en couronne simple.

"Pores génitaux unilatéraux. Deux testicules par proglottis. Muscles longitudinaux divisés en deux couches, dont l'interne ne comprend que huit faisceaux.

"L'utérus sacciforme remplit tout le proglottis mûr."

Fuhrmann (1906e: 738) places the genus Diorchis in its present group of genera saying as follows:

"Das Genus Hymenolepis bildet mit den Genera Aploparaksis Clerc, Diorchis Clerc und Oligorchis Fuhrmann eine sehr natürliche Gruppe, welche manchen gemeinsamen Zug in der Art der Bewaffnung und der Anatomie zeigt und deshalb sehr wohl eine besondere Unterfamilie der Cyclophylliden zu bilden berechtigt ist."

In the next paragraph Fuhrmann gives a diagnosis and names the subfamily Hymenolepinae. In 1908 he places these four genera in the Hymenolepididae. Ransom (1909) places these four genera in the subfamily Hymenolepidinae giving a diagnosis and list of species with references to their descriptions.

GENUS HAPLOPARAXIS (CLERC) 1903

The genus was first set up by Clerc (1902a) under the name of Monorchis to contain those species of cestodes which possessed but one testis in a proglottid. In 1903 he displaced the name Monorchis with Aploparaksis*

* The name should be spelled Haploparaxis.

since he had found that the former had already been given to two species of trematodes. In the preliminary report Clerc includes six species as follows: *H. filum*, as tpye, *H. crassirostris*, *H. hirsuta*, *H. cirrosa*, *H. dujardini*, and a variety of *H. filum*, viz: *pseudofilum*, which he described as a new species. In the complete report of 1903, Clerc describes an additional new species *H. penetrans*, and reduces his former new species, *pseudofilum*, to a variety of *H. filum*. The complete list of species now placed in this genus appears in the systematic section of this paper, as well as a diagnosis of the genus.

PROPOSED REVISION OF THE GENUS HYMENOLEPIS

As the information concerning the anatomy of the various species of Hymenolepis was brought together for comparison, it soon became apparent that the testes were usually the most satisfactorily described of the internal organs. Their position was usually stated, and, in a large percentage of cases, figured. This fact suggested the possibility of arranging a number of groups of species which might be made use of in constructing a key. As a further indication of the usefulness and the reliability of such groupings, it was noted, when a study of the material collected was undertaken, that the testes were invariably characterized by the same relative positions with reference to each other in all the proglottids of a strobila, and likewise, in other specimens of the same species. The few exceptions which may be found, and some are usually found, may be construed as abnormal or unusual, and as suggestive of the condition in the primitive ancestral forms of the group. This point is well illustrated by *Weinlandia lateralis* which has two testes placed on the posterior border and the third in front of and lateral to the antiporal posterior organ. The ovary is located behind and lateral to the anterior antiporal and lateral to the posterior antiporal testes, as is shown in figure 54. This position is characterized by its extreme regularity; not a single variation has been noticed. In the young proglottids where the early conditions are first visible, the testes are so placed, which indicates that these are the positions where the testes are fundamentally located, and that they are not pushed into it by the pressure of the very large cirrus sac and the ovary, even when these organs are fully developed.

Species with the testes in a transverse row are the most constant with respect to the position of the testes. As examples of this may be mentioned *Hymenolepis lobulata* and *Hymenolepis cuneata* which have two testes on the poral side of the ovary and vitelline gland and one on the antiporal. The most outstanding exception to this is *Hymenolepis sacciperum* in which the testes are arranged two antiporal and one poral in about 95 per cent of the proglottids, while in the remainder either the arrangement differs from this or the number is other than three. This case is discussed more in detail later and an explanation offered for each of these irregularities. In a general way it may be stated at this point that they are believed to indicate the ancestral condition of the group, and that the various types of testicular arrangement found in the present species have developed from a primitive form with no fixed arrangement. A further point of interest is that among the species which do not have the testes arranged

in the same manner in all the proglottids of the strobila, there are some which have a very variable pattern, as does *Wardium variabile*, while in *Weinlandia microcirrosa* the variability is restricted within certain limits. In the latter, two of the testes are always posterior and the third anterior to the antiporal testis, but may be either medial, lateral, or directly anterior to it. In this species the arrangement is considered to be sufficiently limited to be included in the genus Weinlandia, which is characterized by having two testes posterior and one anterior to the antiporal testes. In other words, from a phylogenetic standpoint, the species has become sufficiently stable in its arrangement to indicate to what group of species it is the most closely related.

In the study of the anatomy of the species collected from American birds, several morphological details have been found which indicate that the testes of the species of Hymenolepis are compound organs. A discussion of these data is given in the following pages and under the following headings: (1) the irregularity in the number and branching of the vasa efferentia, (2) the lobing of the testes, and (3) the number and irregularity in position of the testes in *Hymenolepis sacciperium*.

Early in the comparative study of the species, the arrangement of the vasa efferentia suggested a possible relationship between the testes. As an illustration, in *Hymenolepis cuneata* (Fig. 50) the ducts from the two poral testes join and then their common duct unites with the one from the antiporal testes to form the vas deferens. In a species which had two testes poral and one antiporal, if the ducts from the posterior organs joined first, it would indicate that the anterior testis was homologus with the antiporal testis in *Hymenolepis cuneata* and would belong to the same natural group. As a result of this, the different patterns of testes arrangements may be considered to have risen through a rearrangement of that pattern found in the primitive form. As an illustration, Ransom (1902) gives a figure of the arrangement in *Hymenolepis megalops* (Fig. 15) in which the two antiporal ducts joint before uniting with the poral duct. To correlate this with the arrangement found in *H. cuneata*, the two poral testes would have to be shifted to the antiporal position, a seemingly impossible rearrangement, and indicating that these two species would belong to different natural divisions. A very real difficulty was at once encountered in the literature since there are only about seven descriptions of species in which there is any reference to the manner of union of the vasa efferentia; most of these are noted only in figures, and no statistical records of any sort given as to their regularity. Upon these grounds, it would be impossible to secure enough data to make anything like a satisfactory arrangement of such an exceedingly large number of species in a key by means of which one would be able to classify a cestode of this genus which he might have.

The study of the vasa efferentia in the material available revealed some interesting facts concerning which a rather detailed discussion of

several species seems now advisable. In *Weinlandia microcirrosa* (Fig. 1) there were found in four consecutive proglottids, which were examined in frontal section, all of the possible patterns of union of the vasa efferentia. In figure 1a the ducts from the two posterior testes join first, in 1b and 1c, the ducts from the two antiporal join first, while in 1d all three join at the same point. *In Weinlandia macrostrobilodes* one of the seven proglottids of which the arrangements are represented in figure 2e, has the ducts from the three testes all joining at the same point, while in all the others figured those from the two antiporal testes join first.

In some proglottids, more than one duct from a testis has been observed. These may unite and their common duct join that from another testis, as they do in figure 1c, or they may remain separate as in figure 4c. If it be assumed that the testes of Hymenolepis have been reduced in number from, say six in the ancestral form to three in the present types by the uniting of testes, it seems possible that the ducts have also united or that some of the primitive ducts have persisted and others have not. It is possible upon this basis to explain the diversity of pattern in species which probably have a constant pattern. Take as an illustration the pattern shown in figure 4c; if ducts Nos. 1 and 2 should fuse, retaining the position of No. 1, or that 2 should fail to develop, it would give the pattern found in figure 4a, while if, on the other hand, No. 2 became the functional duct, the result would be the pattern shown in figures 1d and 2e. Some of the patterns show considerable evidence for the fusion of the ducts, as for example, figure 4b, where there are two ducts from the poral testis, with a cross connection between them. If in this instance the posterior antiporal testis is a compound structure made up of three simple organs, each originally with a single duct, and the present single duct from it made up of the three primitive ducts and the poral testis made up of two simple organs, one can readily determine the original pattern. Another interesting pattern in this connection is that shown in figure 3e, which indicates that the single duct from the anterior antiporal testis is made up of three ducts or that it contains two and the single duct from the antiporal posterior testis contains two, either of which would result in the pattern shown. Figure 3d is suggestive of the union of the ducts from two testes resulting in a different pattern. If these had remained separate as far up as is indicated, the result would be a pattern similar to that found in figure 2e, where all the ducts join at the same point, or if the vas deferens had remained simple as far up as the opening between its two portions, the arrangement would be like in figure 4a. An examination of the exceedingly complex patterns shown in figures 6, 10, and 11 reveals the fact that any pattern can be obtained by considering that the testes are compound and that their ducts are formed by the union of the primitive ducts or by the failure to retain some of the primitive ducts.

Reference has been made above to the probable number of testes which have entered into that organ in the present condition, namely that there is a possibility of three in the anterior antiporal testis in figure 3e, or two in both the antiporal testes on a basis of the arrangement of the ducts. Several proglottids have two distinct ducts to a testis, namely figures 2a, b, f, 4c, and several in the proglottids figured from *Weinlandia planestici*, as in figures 6, 10, and 11. Three instances are shown in figure 6 of a testis having three ducts, and one in figure 2c. The evidence for a larger number of testes entering into that organ of present forms rests on Fig. 2d, which shows four ducts attached to the anterior antiporal testis.

A further indication of the compound nature of the testes is to be found in their being lobed. These organs are found to be regularly lobed in *Weinlandia macrostrobilodes* and *Weinlandia introversa*. The most interesting species, however, in this connection is *Hymenolepis sacciperium*, which is further characterized by the unusual variability in the number of testes discussed at length in the next paragraph. It is not uncommon for the testes to be lobed or constricted anterioposteriorly as is shown in proglottids in figure 44. Those which have but two testes, one on each side of the ovary, as is found in Fig. 44h, can be explained by considering that the two testes on either side in proglottid e have united and the constriction indicates the plane of fusion. Proglottid i indicates that the two on the poral side only have joined and j suggests that the two adjacent to the ovary on the antiporal side have fused. An interesting fact in this connection is that no testis was observed which had a constriction that did not have it directed along the anterioposterior axis of the strobila. These testes were studied in sections and found to be single organs and not to be due to separate organs overlapping one another, which would give this effect in toto mounts. Unfortunately in this species, the vasa efferentia were so poorly defined and lay so close to the testes that they could not be traced with any degree of certainty beyond the region of the vas deferens. The arrangements of the ducts indicated in figure 5 have some interesting irregularities and are suggestive of fusion of the ducts and testes.

The number of testes found in the proglottid also is another indication that there is a change taking place in the number of testes in this group of cestodes. It is only occasional that one finds a number other than three, but one does find in almost any species proglottids with one, two, and four testes in a proglottid. One of the species studied, however, is interesting in this respect. A careful examination of almost 1400 proglottids in two specimens of *Hymenolepia sacciperium* showed that in one specimen 5 per cent and in the other 7 per cent of the total in each possessed a number other than three or an arrangement other than that typical for the species. A representative figure of each of these types of arrangements is shown in figure 44. Of the total number, 1307 had the typical arrangement shown

in i and j or two testes antiporal and one poral to the ovary. The numbers of each of the other types found are as follows: of the type shown in proglottid c 29, d 8, e 5, f 20, g 16, and b, only 2.

It is now necessary to discuss some of these conditions in order to see how they may have come about. The presence of one testis on each side of the ovary has been referred to above as being possible through a fusion of two testes in each of these respective positions. The relative size of the testes is often evident as where there is only one it is invariably much larger than either of those where there are two. The lobing or constrictions in these organs in the anterioposterior axis has been referred to above and is frequently evident. The arrangements where there are two on either side of the ovary or two on the poral side and one on the antiporal may be explained on the basis that either fusion has or has not taken place in that location. The fact that so many proglottids (20) were found which contain but two testes on the antiporal side is believed to be an indication that this species is still somewhat unstable and shows some relation to another group of species containing only two testes. This may have occurred by fusion or by a failure of the poral testis to develop. Indeed, one sometimes finds groups of cells in the position of the poral testis which stain weakly in a manner similar to those in the testes and these undoubtedly are reproductive cells.

The evidence presented above indicates that each of the three testes of the species assigned to the genus Hymenolepis has been formed phylogenetically by the fusion of at least four simple testes. This has been presented under the following headings: (1) number and irregularity in the arrangement of the vasa efferentia; (2) lobing of the testes, and (3) the irregularities in the number and arrangement of the testes in *Hymenolepis sacciperium*.

There is considerable basis for believing that the evidence presented above does not indicate a splitting in the testes rather than a union. In first place, the ducts are found to be irregular in the youngest proglottids in which they can be recognized indicating that the irregularities are present from the beginning of their development. There is no increasing complexity in the vasa efferentia in proglottids in an anterio-posterior series. Again, the testes, as compared with the ducts, may be said to be physiologically the most active, and if splitting were taking place the testes would be already divided or lobed, and the duct divided only nearest the testes. The contrary is found to be the case when the figures are examined, as for example in figure 2f the two ducts from the anterior testis approach very near to each other at the testis but are widely separated at their opposite ends. A similar arrangement is to be observed in figure 2a, b, d, and 3e. In the third place, more than one vas efferens may connect with a lobe of the testis and with no regularity of position on the

lobe. This is the condition to be expected since the lobing of the testes would probably disappear before the complete union of the ducts. In the fourth place, considered from a phylogenetic standpoint, the most highly developed group of cestodes might be expected to be found in the most highly developed hosts. The occurrence of the members of the Hymenolepididae in birds and mammals is in support of the conclusion that the testes are compound since the cestodes parasitic in lower animals have more numerous testes.

PHYLOGENY OF SPECIES IN THE GENUS HYMENOLEPIS

It is believed that the compound nature of the testes discussed in the preceding section has a direct bearing upon the relationships of the various groups of species which are to be made in the following section. An attempt was made in the last section to show that the three testes found in the present species is the result of the fusion of several simple organs present in primitive forms.

Another characteristic, which has not been referred to as yet, and which is believed to be very important, is the position of the pore and the relation of the genital ducts to the longitudinal excretory canals. An outstanding fact is that the genital ducts are always dorsal to the longitudinal excretory canals in all the species studied and in all the proglottids. This fact is not so difficult to determine as it might appear for in many species it can be very readily ascertained from toto mounts by careful focusing with a high power lens. This depends, however, upon the nature of the cirrus sac and the excretory canal. If they are both small and lie close together, it is sometimes impossible to determine this point with certainty from a toto mount and sections then become necessary. This point has been carefully studied in all the species, and in several specimens of each where such a number was available, and not a single exception was found. In young proglottids the position of the earliest stage of the cirrus sac is dorsal to the excretory ducts. But three exceptions have been described which have come to the notice of the writer. *H. asymetrica* Fuhrmann 1918 has the genital ducts regularly passing above, but exceptionally they may pass between the excretory ducts. *H. spinosa* Linstow 1906 is described as having the genital ducts passing between the excretory ducts, and *H. clausa* Linstow 1906 has the cirrus sac above and the vagina ventral, the two merging and the pore being absent. A careful restudy of these species should be made with the view to determining the constancy and the importance of these facts. It may be that these are representative of distinct groups to which others of the incompletely studied species may belong.

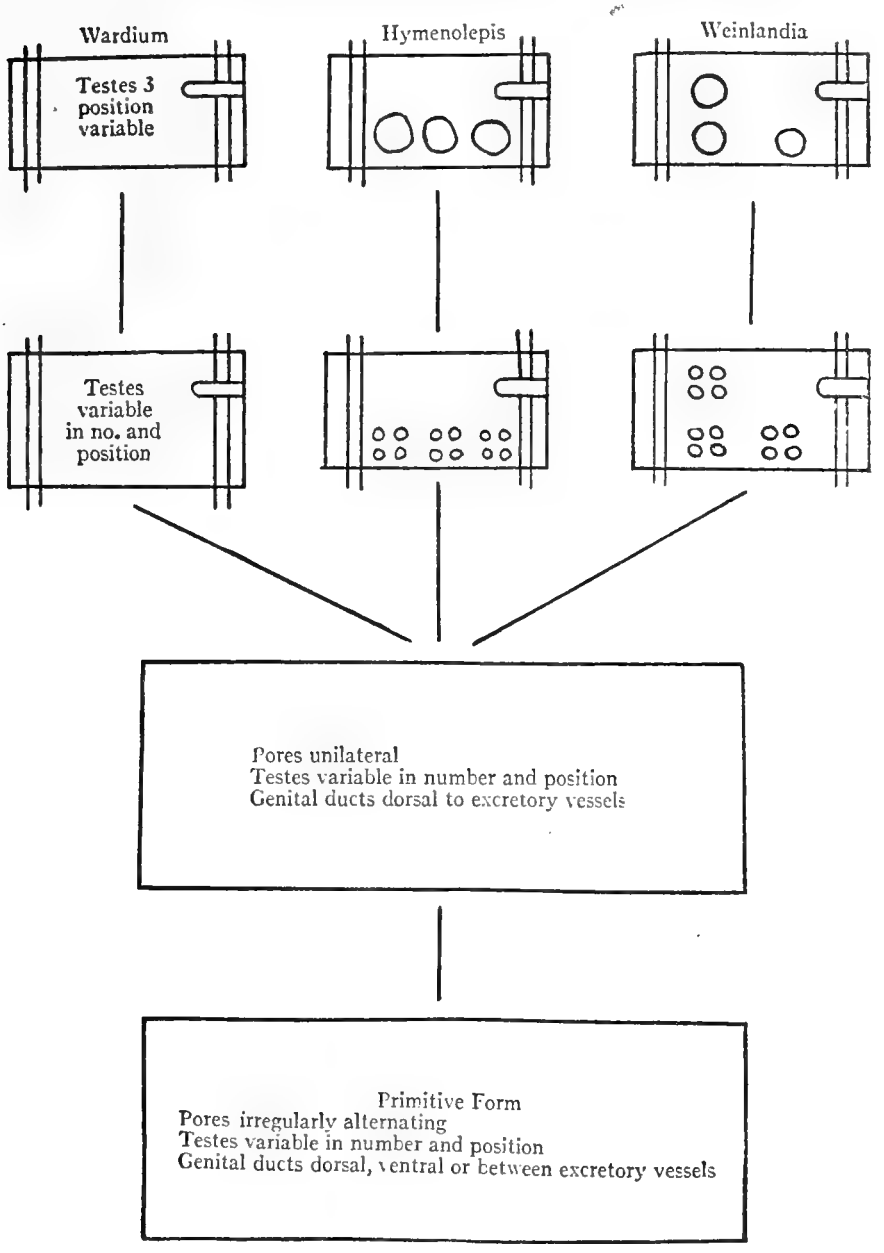
The regularity of the unilateral position of the genital pores has been referred to above, and the fact noted that but one exception has been observed, that of two proglottids in one specimen of *Weinlandia lateralis* having the pores on the opposite side from all the other proglottids in the specimen. It is believed that the regularity in position of the genital pores and genital ducts with reference to the excretory ducts is a very important morphological character which should be carefully determined in the future study of these forms.

It is now possible to formulate a conception of the ancestral form from which the various species assigned to the genus Hymenolepis have been derived. At least six testes and as many as twelve were present in a proglottid since the evidence presented above shows that at least two and possibly as many as four have joined to form a single testis of the present species. These testes had no definite pattern in the various proglottids of the strobila. The genital pores also alternated from side to side and the genital ducts were to be found dorsal, ventral or between the longitudinal excretory ducts. The first forms with fixed characters which diverged from this most probably had the genital ducts dorsal to the excretory canals and the pores unilateral. The most distinctive morphological character next to appear probably was in connection with the testes. It seems quite possible that the several testes first became localized in groups in definite locations in the proglottid. As an illustration, let us assume that there were twelve testes and that these became localized along the posterior border of the proglottid in groups of 4 or that two groups came to be found along the posterior border and the other in front of the posterior antiporal group. The next stage was seen in the union of these testes in those respective positions. In this manner it becomes apparent that the groups of species which have similar patterns of testes arrangement are fundamentally related, and that this relationship goes back to their common origin. They are thus separated from the species having other arrangements in a distinct and peculiar manner. The study of material and of descriptions reveals one group of species which have the testes arranged in an irregular manner. In the development of this group it may be assumed that the position of the groups of testes in the ancestral form did not become stabilized as to position in the proglottid, consequently when union took place, the compound organ retained this characteristic, and this group of present day species presents a variable pattern of testes arrangement.

Upon the basis of the above observations the author believes that the pattern of the testes arrangement is sufficiently reliable, easily enough ascertained, and goes back far enough in the phylogeny of the group to constitute a generic character. The position of the ovary in the proglottid and with reference to the testes at first seemed to be important, but it soon became apparent that this was much less clear cut and well defined since it usually overlaps the testes and sometimes it was necessary to use the position of the vitelline gland instead. This point is discussed more at length in the section on the history of the genus.

The following diagram (Textfig. 2) is believed to represent the relationships set forth above among the species which have been assigned to this genus.

TEXTFIGURE 2. DIAGRAM SHOWING THE PHYLOGENETIC RELATIONSHIPS BETWEEN THE GENERA WARDIUM, HYMENOLEPIS, AND WEINLANDIA.



KEY TO SUBFAMILIES AND GENERA OF FAMILY HYMENOLEPIDIDAE

1(2) Four testes in each proglottid
Subfamily Oligorchinae — Oligorchis

2(10) Three testes in each proglottid
Subfamily Hymenolepidinae 3

3(7) Excretory vessels 4 in number, the genital ducts probably always passing dorsal to them. Scolex well developed. No pseudoscolex. Rostellum an introvert, not an introvert, or rudimentary, and armed with a single or double crown of hooks or unarmed 4

4(5) Position of the testes variable — Wardium

5(6) Testes in a transverse row — Hymenolepis

6(7) Two testes posterior, the third anterior to the posterior antiporal testis — Weinlandia

7(3,8) Excretory vessels 4 in number. The genital ducts pass between the longitudinal excretory vessels. Longitudinal muscle bundles in two layers. Scolex well developed. Rostellum proboscis-like, with hooks distributed over its surface. Strobila well marked off into proglottids — Echinorhynochotaenia

8(3,9) Excretory vessels 10 in number. Longitudinal muscle bundles in a single layer. Strobila well marked off into proglottids. Scolex well developed. Rostellum armed with a single crown of hooks — Hymenofimbria

9(3,10) Longitudinal excretory vessels 3 to 11 in number. Scolex small. Pseudoscolex present. Strobila not marked off into distinct proglottids — Fimbriaria

10(11,1) Two testes in each proglottid
Subfamily Diorchinae — Diorchis

11(1) One testes in each proglottid
Subfamily Haploparaxinae — Haploparaxis

FAMILY HYMENOLEPIDIDAE (ARIOLA) 1899

Family diagnosis: Cestodes with regularly from one to four testes in each proglottid. Rostellum either unarmed or armed with a single or double crown of hooks. Rarely the hooks are distributed over the surface of the rostellum. Genital pores unilateral. The uterus usually sac-like. Proglottids usually broader than long. Longitudinal muscle bundles in one or two layers.

Type genus: Hymenolepis Weinland 1858

The names of hosts of previously described species used in this paper are in agreement with the references cited, those of new species were obtained from the A. O. U. Check-list of 1910.

It should be indicated at this point that, due to the inadequate descriptions of many of the species, a number have been placed in the genera from the genus Hymenolepis with considerable doubt as to their relationship, and that before a final determination is made of any new material the original description should be consulted.

SUBFAMILY OLIGORCHINAE

Subfamily diagnosis: Hymenolepididae having regularly four testes in each proglottid.

Type genus: Oligorchis Fuhrmann 1906

GENUS OLIGORCHIS FUHRMANN 1906

Generic diagnosis: Four testes in a proglottid. A single set of reproductive organs in a proglottid. Genital pores unilateral, marginal or dorsal in position. Genital ducts pass dorsal to the longitudinal excretory vessels. Rostellum armed with a single crown of hooks.

Type species: *Oligorchis strangulatus* Fuhrmann 1906

OLIGORCHIS STRANGULATUS FUHRMANN 1906

Fuhrmann 1906a: 217-218 (Fig. 26-29).
Host: *Elanoides furcatus* (L.).
Locality: Brazil.

Length 10 cm. Width 1 mm. Hooks 14 to 16, 34μ long. Ovary and vitellaria median, the former but slightly lobed. Testes irregular in position. Proglottids much wider than long.

OLIGORCHIS DELACHAUXI FUHRMANN 1909

Fuhrmann 1909: 29 (Figs. 36-37).
Host: *Phalacrocorax africanus* (Gm.).
Locality: Egypt.

Scolex absent. Position of testes variable. Female sex glands not well developed, but are on the poral side of the proglottid. Cirrus sac reaches beyond the excretory vessels, its greatest diameter being at the poral end. Vagina is straight with seminal receptacle on its inner end. Proglottids appear from figure 36 to be much wider than long.

OLIGORCHIS YORKEI (KOTLAN) 1923

Synonym: *Dilepis yorkei* Kotlan 1923.
Kotlan 1923: 59-63, (Figs. 1-4).
Host: *Megapodius brunneiventris* Mey.
Locality: Friedrich-Wilhelmshafen.

Length 15 to 20 mm. Mature proglottids 0.2 to 0.4 mm in width and 0.05 to 0.1 mm in length. Gravid proglottids are 0.3 to 0.5 mm in width. Rostellum armed with from 50 to 52 hooks in a double crown. The hooks of the anterior row are 135μ and those of the posterior row 148 to 151μ in length. Male and female reproductive organs median in position. Genital pores unilateral. Vagina short, narrow, and provided with a large receptaculum seminis. Ovary consists of 4 rounded or oval sacs, 1 in the poral half and 3 in the antiporal half of the proglottid, joined by thin walled canals which uniting form the oviduct. Uterus a thin walled sac, the wall of which atrophies in the posterior proglottids.

The internal structure of this cestode indicates its close relationship to those species already assigned to the genus Oligorchis. The double crown of hooks is not believed to be a character of sufficient importance to exclude it from the family Hymenolepididae. The constancy of the number of the testes in the numerous species of the several genera of the family is such an outstanding characteristic that it serves to separate this group of genera from other genera in a distinct and peculiar manner.

OLIGORCHIS LONGIVAGINOSUS N. SP.

[Figs. 12-16]

The material which formed the basis of the following description was taken from the large intestine of *Pelecanus erythrorhynchos*, the white pelican in Yellowstone National Park, Wyoming, on August 10, 1917. Cotypes were deposited in the Ward collection, comprising five toto mounts and four sets of serial sections, catalogue numbers 25.22, and 25.23. For the most part the specimens are only fairly well fixed so that some of the details, such as vasa efferentia, could not be made out.

The specimens vary in length from 15 mm to 60 mm and in maximum width from 0.5 to 0.8 mm, according to the stage of sexual maturity and the condition of contraction of the worms when fixed. The width just behind the scolex is about 175-200μ, while in the region where the male and female reproductive organs are well developed, it is about 500μ and in the posterior portion where the uterus is fully distended, somewhat narrower, about 350μ.

The scolex (Fig. 13) is a conspicuous portion of the worm, having a width up to almost 0.6 mm and a length of about 0.4 mm. The rostellum is strongly developed, being about 200μ wide and about 100μ long. The rostellum has, apparently, a single crown of large hooks the shape of which is indicated in figure 16. They are 88 to 92μ long, and about 20 in number on one rostellum, which was retracted so that an accurate count could not be made. Another unretracted rostellum had 10 and another 12, both of which showed evidence of having lost hooks since those still remaining were twisted out of a regular arrangement, and on one side of one there were five set closely together, while on the other there was but one. An examination of the retracted rostellum appears to show a double crown of hooks, but when examined more closely, it seems quite evident that this is due to the position of the bases of the hooks when retracted. The blades of the hooks are directed outward showing that the rostellum is an introvert and the points of the hooks are observed to be in two rows. When the position of the dorsal root of the bases is examined, it is seen that those of the hooks of the posterior row are inside those of the anterior row which would result in the blade being carried farther outward than in the case of the anterior row. This difference in position of the points together with the fact that the scolex is tilted somewhat so that an exact lateral view is not obtained, would account for the appearance of two rows of hooks. An unretracted rostellum with a full complement of hooks would be conclusive proof of the exact arrangement but such is not at hand, and there is little probability of gaining more data by sectioning the one now under consideration. The general form, size, muscular arrangement, and structure of the proglottids agree with that of the other scolices and proglottids so that there is no doubt that they are all of the same species. There was no evidence of a double crown in any of the unretracted specimens, and, while the case is not clear, the probability is that there is but a single crown.

The testes are usually four in number but have no regularity of position. They are generally spherical in shape and dorsal in position in the center or posterior portion of the proglottid. Occasionally one is found beneath a lobe of the ovary. The position indicated in figure 15 is a little more common, but they may be in any position with reference to each other, dorso-ventrally as well as laterally. Figure 14 shows their location in three consecutive proglottids. The number of the testes varies slightly,

since in a count in 106 proglottids from 3 specimens, 99 were found to possess four testes, four had three, and one seemed to have five. The size varies considerably, occasionally one is observed one-half or two-thirds the size of the others in the proglottid. The cirrus sac reaches about half way across the proglottid, and gradually increases in size toward the inner end. It contains a small seminal vesicle and a large conspicuous cirrus. The latter extends the full length of the sac in a direct course, bends at the inner end and shortly connects with the internal seminal vesicle. The cirrus is large and conspicuous, being protruded in most of the proglottids of the strobila. Due to the poor fixation of the material, the vas deferens and vasa efferentia were not found, therefore no statement can be made concerning the existence of an external seminal vesicle.

The ovary (Fig. 15) is centrally located, usually a little anterior to the testes and ventral to them in position. It is usually divided into from four to six lobes which are rounded and knob-like at their distal ends. The vitelline gland is a spherical or oval structure, dorsal to the central narrow portion of the ovary and without lobes. The vagina is unusually long, extending from the pore across the proglottid to the excretory ducts of the antiporal side and back again usually to the region of the pore, then across again to antiporal excretory duct and medially and posteriorly to the region of the ovary. The inner end enlarges to form a seminal receptacle which is conspicuous in the advanced stages of sexual maturity. The vagina opens into the shallow genital atrium ventral to the cirrus sac.

The position of the pore is not marginal but slightly dorsal on the left hand side of the proglottid, at about the junction of the anterior one-third and posterior two-thirds of the proglottid. It was noted that the pore seemed to change from side to side occasionally, but in no instance could this be positively determined since there were always at least two proglottids in which the pore or cirrus could not be located between the regions of change. In order to find out the exact structure at one of these points, one of these regions was sectioned. It was found that the muscles showed a twist of the whole chain and that the pores could be traced in a symmetrical row across the side of the strobila in the proglottids between those where it was on one side and those in which it was on the opposite side. This shows that there has been a twisting of the strobila in the process of fixation. The position of the ovary and testes ventrally and dorsally can be determined in toto mounts on the two sides of these regions and it is found that the pore is on the left hand side in each case.

The longitudinal muscles are poorly developed, and can scarcely be said to consist of two layers. Although the bundles are scattered dorsoventrally, they are all about the same size. The longitudinal excretory vessels are four in number, and located near the lateral border of the proglottid. They are about the same size, and vary in position, being

pushed ventrally on the poral side by the cirrus sac, and turned somewhat laterally in places. The genital ducts always pass above the excretory vessels.

Of the species which have previously been described as having regularly four testes, *Oligorchis yorkei* (Kotlan) 1923, having two rows of hooks, approaches the nearest in general structure to the one described above. The most outstanding difference is in the nature of the ovary. In *O. yorkei* it consists of four separate sacs, one poral and two antiporal, connected by slender ducts uniting to form the oviduct, while in the above described form it consists of from four to six lobes with knob-like enlargements at the ends. The vagina is short in *O. yorkei* while in our species it is very long, and the cirrus sac is long and rather narrow and coiled, while in the latter it is short and bulb-like. The hooks also are different in that they are 50 to 52 in number in two rows and 135 to 151μ in length, in contrast to about 20 in number and 88 to 92μ in the above described form. The other three species described as having four testes are all so different in internal structure that it seems unnecessary to discuss them in detail.

DOUBTFUL SPECIES

OLIGORCHIS PAUCITESTICULATUS FUHRMANN 1913

Fuhrmann 1913: 17 (Fig. 8).

This species has from 7 to 11 testes, but Fuhrmann placed it in the genus Oligorchis because of the presence of an external and internal seminal vesicle and revised his original description of the genus accordingly. However, the small and constant number of testes is such an outstanding characteristic of the numerous species of the family Hymenolepididae that it seems that this species should be excluded. The external and internal seminal vesicles, while they are very common and probably almost universal in the family, cannot be considered as anything else but a widened portion of the vas deferens, and are found in all degrees of relative size. They may serve as specific characters but seem scarcely of sufficient importance to cause the modification of generic and family diagnoses to admit species with other more evident unrelated characteristics.

SUBFAMILY HYMENOLEPIDIDAE (PERRIER) 1897 RANSOM 1909 (EMENDED)

Subfamily diagnosis: Hymenolepididae with regularly three testes in each proglottid.

Type genus: Hymenolepis Weinland 1858.

GENUS HYMENOLEPIS WEINLAND 1858

Three testes in a transverse row. Rostellum generally well developed and armed with a single crown of hooks, or it may be unarmed. Vas deferens with internal and external seminal vesicles. Genital ducts dorsal to the longitudinal excretory vessels, or exceptionally they may be between. Pores unilateral.

Type species: *Hymenolepis diminuta* (Rudolphi 1819) Blanchard 1891.

List of the Species in the Genus Hymenolepis

All three testes lie close together or somewhat separated but not so placed that the ovary lies between any two of them. Ovary ventral, anterior, or posterior; but not lateral to the testes.

1. *Hymenolepis breviannulata* Fuhrmann 1906.
   See Fuhrmann 1906c: 445 (Fig. 25).
2. *Hymenolepis longicirrosa* Fuhrmann 1906.
   See Fuhrmann 1906e: 751-752 (Figs. 17 and 18).
3. *Hymenolepis longivaginata* Fuhrmann 1906.
   See Fuhrmann 1906e: 752.
4. *Hymenolepis pauciovata* Fuhrmann 1906.
   See Fuhrmann 1906c: 447 (Figs. 28-31).
5. *Hymenolepis septaria* von Linstow 1906.
   See von Linstow 1906a: 177 (Fig. 21).
6. *Hymenolepis serrata* 1906.
   See Fuhrmann 1906c: 448 (Figs. 32-33).
7. *Hymenolepis solowiowi* Skrjabin 1914.
   See Skrjabin 1914: 467.
8. *Hymenolepis himantopodis* Krabbe 1869.
   See Krabbe 1869: 309; Fuhrmann 1906e: 748.
9. *Hymenolepis hemignathi* Shipley 1897.
   See Shipley 1897: 613-621, 10 fig.
10. *Hymenolepis spinosa* von Linstow 1906.
    See von Linstow 1906a: 178 (Figs. 24-25).
11. *Hymenolepis brasiliensis* Fuhrmann 1906.
    See Fuhrmann 1906c: 446 (Fig. 26).
12. *Hymenolepis furcifera* (Krabbe 1869).
    See Krabbe 1869: 306 (Figs. 176-178); von Linstow 1908: 38-39 (Figs. 1-2).
    See Krabbe 1869: 306 (Figs. 176-178) Linstow 1908: 38-39 (Figs. 1-2).

13. *Hymenolepis aequabilis* (Rudolphi 1810) Cohn 1901.
See Krabbe 1869: 316-317 (Figs. 212-213 (*Taenia aequabilis*); Stiles 1896: 33-34 (Figs. 29-30) (*Dicranotaenia aequabilis*); Clerc 1903: 290-293 (Figs. 2, 16 & 24) (*Drepanidotaenia aequabilis*).
14. *Hymenolepis musculosa* Clerc 1903.
See Clerc 1903: 303-3-5 (Figs. 17, 23, 29).
15. *Hymenolepis upsilon* Rosseter 1911.
See Rosseter 1911: 147-160 (Figs. 1-9); Fuhrmann; 1913: 26 (Figs. 18-20).
16. *Hymenolepis villosa* (Bloch 1782) Wolffhügel 1899.
See Krabbe 1869: 303-304 (Figs. 168-169) (*Taenia villosa*); 1882: 354-355 (Fig. 19-22). Wolffhügel 1900: 184-188, fig. 11.
17. *Hymenolepis compressa* (Linton 1892) Fuhrmann 1906.
See Linton 1892: 108-110 (Figs. 83-92) (*Taenia compressa*). Kowalewski 1907: 775 (Figs. 7-11) 1908: 638-641 (Figs. 7-11).
18. *Hymenolepis baschkiriensis* Clerc 1903.
See Clerc 1903: 288-290.
19. *Hymenolepis exigua* Yoshida 1910.
See Yoshida 1910: 235 (Figs. 1-10).
20. *Hymenolepis fragilis* (Krabbe 1869) Fuhrmann 1906.
See Krabbe 1869: 300-301 (Figs. 158-160) (*Taenia fragilis*). Fuhrmann 1906e: 747-748 (Figs. 11-12).
21. *Hymenolepis macrocephala* Fuhrmann 1913.
See Fuhrmann 1913: 19-21 (Figs. 9-11).
22. *Hymenolepis nitida* (Krabbe 1869) Clerc 1902.
See Krabbe 1869: 294 (Figs. 133-135) (*Taenia nitida*). Clerc 1903: 310-315 (Figs. 26, 27, 30, 31, 36, 38, 40-42).
23. *Hymenolepis nitidulans* (Krabbe 1882) Fuhrmann 1906.
See Krabbe 1882: 353 (Figs. 16, 17) (*Taenia nitidulans*); Rosseter 1907: 36-39 (Figs. 1-15).
24. *Hymenolepis pachycephala* (von Linstow 1872) Fuhrmann 1906.
See von Linstow 1872: 55 (Fig. 2-4) (*Taenia pachycephala*); 1904: 305. (Fig. 17-20) (*Drepanidotaenia pachycephala*).
25. *Hymenolepis rectacantha* Fuhrmann 1906.
See Fuhrmann 1906c: 446-447 (Fig. 27).
26. *Hymenolepis trifolium* von Linstow 1905.
See von Linstow 1905: 361-362 (Fig. 6-7).
27. *Hymenolepis lobulata* n. sp.
See this, p. 43.
28. *Hymenolepis cuneata* n. sp.
See this, p. 45.

The two antiporal testes separated from the poral and the space thus formed occupied by the female reproductive glands.

29. *Hymenolepis anatina* (Krabbe 1869) Cohn 1901.
See Krabbe 1869: 287-288 (Figs. 114-116) (*Taenia anatina*). Schmidt 1894: 65-112 (Pl. 6) (*Taenia anatina*). Stiles 1896: 39-40 (Figs. 100-115) (*Drepanidotaenia anatina*).
30. *Hymenolepis bisaccata* Fuhrmann 1906.
See Fuhrmann 1906c: 444-445 (Figs. 21-24).
31. *Hymenolepis capillaris* (Rudolphi 1810) Fuhrmann 1906.
See Krabbe 1869: 307, (Fig. 179) (*Taenia capillaris*). This species is placed in this genus on the basis of the statement of the similarity between *H. capillaris* and *H. multistriata* made by Fuhrmann, 1908: 75, but its relationships are incompletely understood.
32. *Hymenolepis clandestina* (Krabbe 1869) Cohn 1904.
See Krabbe 1869: 316 (Fig. 208-209) (*Taenia clandestina*). Cohn 1904: 243-246 (Figs. 9-12).
33. *Hymenolepis creplini* (Krabbe 1869).
See Krabbe 1689: 317 (Figs. 214-215) (*Taenia creplini*). Cohn 1901: 304-307 (Figs. 31-33).
34. *Hymenolepis echinocotyle* Fuhrmann 1907.
See Fuhrmann 1907: 532-533 (Figs. 37-38),
The Zoologisches Museum der Universität, Berlin, very kindly gave material of this species to the Ward Helminthological Collection at the University of Illinois, Urbana; this was of great value in the author's work. This courtesy was greatly appreciated.
35. *Hymenolepis inermis* Yoshida 1910.
See Yoshida 1910: 239-241 (Figs. 11-16).
36. *Hymenolepis kowalewski* Baczynska 1914.
See Baczynska 1914: 219-221 (Figs. 51-54).
37. *Hymenolepis linea* (Goeze 1782) Wolffhügel 1899.
See Krabbe 1869: 327-328 (Figs. 248, 249) (*Taenia linea*). Wolffhügel 1900: 189-190 (Fig. 112).
38. *Hymenolepis multistriata* (Rudolphi 1805).
See Cohn 1901: 302-304 (Fig. 30).
39. *Hymenolepis retracta* von Linstow 1905.
See von Linstow 1905b: 4 (Fig. 15).
40. *Hymenolepis meglahystera* von Linstow 1905.
See von Linstow 1905b: 5 (Figs. 16-18).
41. *Hymenolepis orthacantha* Fuhrmann 1906.
See Fuhrmann 1906e: 754 (Figs. 23-25).
For this species also the author is indebted to the Zoologisches Museum der Universität, Berlin, which donated alcoholic material upon the request of Professor Ward to the Helminthological Collection at the University of Illinois, Urbana.
42. *Hymenolepis sacciperium* n. sp.
See this report, p. 48.

The two testes on the side toward the pore separated from the third, the space between occupied by the female reproductive glands.

43. *Hymenolepis multiglandularis* Baczynska 1914.
See Baczynska 1914: 211-214 (Figs. 40-44).
44. *Hymenolepis brachycephala* (Creplin 1829).
See Krabbe 1869: 294-295 (Figs. 136-140) (*Taenia brachycephala*). Cohn 1901: 280-284 (Figs. 13-14).

Ovary antiporal to the three testes but extending beneath the antiporal testis.

45. *Hymenolepis przewalskii* Skrjabin 1914.
See Skrjabin 1914: 471.
46. *Hymenolepis venusta* Rosseter 1896.
See Rosseter 1898: 10-23 (Figs. 1-17).
47. *Hymenolepis ardeae* (Rudolphi 1819).
See Fuhrmann 1906c: 451-452 (Figs. 37-39) (*H. ardeae*); 1906e: 740. Grateful acknowledgement is here made to the Zoologisches Museum der Universität, Berlin, for loan of material of this species for study.
48. *Hymenolepis elongata* Fuhrmann 1906.
See Fuhrmann 1906e: 450 (Fig. 36).
49. *Hymenolepis setigera* (Frölich 1789) Cohn 1901.
See Stiles 1896: 41-42 (Figs. 147-150) (*Drepanidotaenia setigera*); Clerc 1903: 298-302 (Figs. 3, 6, 7, 12, 22) (*Drepanidotaenia setigera*); Fuhrmann 1906e: 734.
50. *Hymenolepis bilateralis* von Linstow 1905.
See von Linstow 1905b: 5-6 (Figs. 19-21).

Ovary entirely antiporal to the three testes.

51. *Hymenolepis lanceolata* (Bloch 1782) Weinland 1858.
See Stiles 1896: 36-37 (Figs. 43-53, 54-55) (*Drepanidotaenia lanceolata*); Clerc 1903: 302-303, figure 4 (*D. lanceolata*). Ransom 1904: 14, 101-110 (Figs. 108-130).
52. *Hymenolepis tenuirostris* (Rudolphi 1819) Cohn 1901.
See Stiles 1896: 43 (Figs. 165-172) (*Drepanidotaenia tenuirostris*); Cohn 1901: 326-327.

Ovary on the poral side of the proglottid; all three testes antiporal to the ovary.

53. *Hymenolepis biaculeata* Fuhrmann 1910.
See Fuhrmann 1910: 21-22 (Figs. 17-21); 1909: 41.

The two lateral testes placed lateral to the longitudinal excretory vessels on each side.

54. *Hymenolepis microcephala* (Rudolphi 1819).
Synonyms *H. leptoptile* Linstow 1901.
H. multiformis Creplin 1828.

This is a very interesting species and deserves some discussion at this point. It has been recorded from *Ciconia ciconia, Pyrrherodias purpurea, Abdimia abdimia, Plegadis falcinellus, Ardea cinerea, Nycticorax nycticorax,* all of which are Ciconiiformes and from Europe and Africa. The species is described as having a length of from 100 to 300 mm. That this is a very characteristic form is indicated by the position of the testes. They are so placed that the two lateral ones are outside the excretory vessels, and, according to Cohn (1909: Taf. XI, fig. 14) in a transverse row, while Fuhrmann (1909) figures (Fig. 41, p. 43) and described them quite differently. Concerning the position of the genital pore, Cohn says: "Der Genitalporus liegt in der Mitte des Gliedrandes auf der rechten Seite auf einer konischen kleinen Erhöhung des Gliedrandes." Fuhrmann (1909) described the testes as follows: 'Die Hoden zeigen eine sehr typische Disposition in dem sie was bei keiner anderen Hymenolepisart der Fall (mit Ansnahme von *H. multiformis* (Crepl.) so angeordnet sind, dass die beiden seitlichen Hoden ausserhalb der beiden weit nach innen verschobenen dorsalen ventralen Wassergefässpaare liegen. Der mediane Hoden liegt vor den weiblichen Genitalien."

The differences between the forms described by Cohn and Fuhrmann indicate that a re-examination of the specimens should be made, but the position of the testes with reference to the excretory vessels is so characteristic and stands in such marked contrast to the other species of the Hymenolepis group that a more careful study may result in the placing of this species in a separate genus. However, it is not possible to define exactly the characters of such a genus at present.

Position of testes with reference to the ovary uncertain

55. *Hymenolepis kempi* (Southwell) 1921.
Synonym *Dilepis kempi* Southwell 1921.
Host: *Phalacrocorax pygmaeus.*
Locality: North Lohtak Lake, Manipur, Assam.

Length 5 cm. Greatest width 1 mm. Posterior proglottids 900μ broad by 400μ long. Genital pores unilateral. Scolex 220μ long by 400μ broad. Rostellum about 170μ long by about 160μ broad. Hooks 20 in two rows, those in the posterior row 135μ and those in the anterior about 175μ in length. Testes in the median field and, according to figure 2, in a transverse row. Genital ducts pass dorsal to the excretory ducts. Uterus large and sac-like, with numerous out-pocketings, and reaching the excretory vessels on either side.

The small and almost constant number of the testes is such an outstanding characteristic of the genera and species of the family Hymenolepididae that it separates them from other Cestoda in a natural and distinct manner. After a study of this large number of species and of the data presented in this report, I do not believe this species ought to be excluded from the family on the basis of the double crown of hooks.

DESCRIPTION OF NEW SPECIES

HYMENOLEPIS LOBULATA N. SP.

[Figs. 32-39]

The specimens upon which the following description is based were collected by N. C. Gilbert at Bass Lake, Michigan, June 9, 1907, and are preserved in the collection of Professor H. B. Ward (No. 17, 180). In this study cotypes were selected comprising sixteen toto mounts and seven sets of serial sections, catalogue numbers 25.5 to 25.13 inclusive. They remain in the Ward Helminthological Collection at the University of Illinois, Urbana. The host was a single specimen of *Podilymbus podiceps* (Linnaeus) or the pied-billed grebe, and the organ the intestine.

External anatomy: The specimens vary from about 60 mm to 85 mm in length and from 2 to 2.5 mm in width. The width immediately behind the scolex varies from less than 100 to 225μ depending upon the state of contraction of the strobila. The width at a number of points was measured in one specimen and is as follows: 20 mm from the scolex, 0.6 mm; 30 mm, 1.3 mm; 26 mm, 1.7 mm; 38 mm, 2mm; 68 mm, 2 mm; 86 mm, 1.5 mm. The proglottids are all much wider than long.

The scolex is 0.6 mm in diameter and almost spherical. The four rounded suckers are 0.25 mm in diameter and but slightly raised above the surface. The rostellum (Fig. 37) has a very interesting shape. It is long and slender, and generally twisted and coiled in preserved specimens. It is crowned at the tip by a knob-like enlargement which has deep marginal lobes, each of which carries a hook on its lateral margin. Anteriorly, this enlargement is but slightly arched. This enlargement is 0.1 mm in diameter, while the stalk part is but 35μ in diameter by about 0.2 mm long. When the rostellum is retracted, the points of the hooks are directed anteriorly, while in the extended condition they are directed backward, showing that the rostellum is an introvert. In the partially retracted condition, they are placed regularly in two rows in a manner indicated in figure 34, while in the completely retracted condition they are closely packed together. The hooks are eight to eleven in number, 14 to 17μ in length, and are shaped like figure 35. Of the scoleces examined, one had eight hooks, three had nine hooks, three had ten, one had eleven, and one had lost all but one hook.

The three testes are placed in a transverse row, two of them being on the poral side of the proglottid. The well-differentiated beginnings of the ovary and vitellaria are distinguishable in the space between and just posterior to the two poral and the antiporal testes in proglottids about 35 mm from the scolex. In this region the testes are oval in outline and 0.2 to 0.25 by 0.15 mm in size. The cirrus sac reaches to or slightly beyond the inner large ventral excretory vessel, and is surrounded by a layer, several cells in thickness, of large clear angular cells. The internal seminal vesicle occupies the larger part of the interior, while the cirrus is a very narrow straight tube which opens into the small, slender and deep genital atrium just dorsal to the vagina. The external seminal vesicle is an elongate, thin-walled structure which is to be found anterior to and between the two poral testes. The testes have functioned and are found to be disappearing in proglottids about 50 mm from the scolex. The pore is to be found on the right hand border in the anterior one-third of the lateral margin.

The start of the ovary is to be found in proglottids about 35 mm from the scolex in the form of a transversely elongated structure with a few small lobes on the anterior border. As development proceeds, it elongates transversely and the lobes increase in number and depth so that in proglottids about 50 mm from the scolex, the organ has the outline and extent as indicated in figure 38. The vitelline gland is situated posterior to the ovary and is a transversely elongated oval organ but slightly lobed. The vagina is at first a clearly differentiated, thin-walled duct which leads at first almost directly medially, then posteriorly ventral to the poral testes, then posterior to the median testes to the region of the beginnings of the ovary and vitellaria. Its inner end is slightly wider than the remainder of its length and becomes widely expanded into a seminal receptacle. Its entire length serves, however, as a reservoir for the spermatozoa, since it becomes a wide tube and completely filled with them. Its course when filled with the spermatozoa in the mature proglottids is very irregular and contains several curves. Both the cirrus sac and vagina pass dorsal to the longitudinal excretory vessels. The uterus is a large transverse sac divided irregularly into lobes. The eggs in all the specimens examined were immature. They have but two shells and no hooks could be made out in any that were examined. The space between the shells is filled with a loose cellular mass which appeared to be breaking up in more mature eggs. The embryos are spherical and vary in diameter from 7 to 12μ and the shell 18 to 28μ. These measurements, however, are not thought to be of much value, especially those of the shell, since they are very much distorted by pressure from adjoining eggs and by shrinkage.

The longitudinal muscles are irregularly placed and all the bundles are of about the same size. Their position varies according to the position

in the proglottid at which the section is selected, being farther from the surface in the posterior than in the anterior. The longitudinal nerve lies about midway between the large excretory vessel and the border of the proglottid. The dorsal excretory vessel is 26 by 10μ in proglottids about 35 mm from the scolex, while the ventral is much larger, being 21 by 8μ size in the same region. No connections could be found between the ducts of the two sides.

Of the species described from the order Pygopodes as listed by Fuhrmann (1908), *H. capillaris* deserves some discussion. The shape of the rostellum is apparently flat as figured by Krabbe (1869) and not lobed. The hooks as figured by Krabbe are different in shape, the basal part being much more curved and the blade more bent, although the size as given by Krabbe is 15μ. The position of the testes and ovary is not well understood. The hooks of *H. furcifera* (Krabbe 1869) are 26 to 33μ in length and much different in shape, the blade being much longer, heavier, and the base more curved than found in the species described above. *Wardium capillaroides* Fuhrmann (1906: 355) from *Podiceps dominicus* (L.) has two of the testes on the antiporal side, the farther one somewhat variable in position but usually in a transverse row. The hooks of this species are larger (21μ) and much more slender in structure in all parts than in the above described species. *H. podicipina* Szymanski 1905 has much smaller testes which are arranged two antiporal, one of which is in front of and ventral to the other. The hooks have much heavier basal parts and about three times as long (42 to 46μ) as in the new species described above.

Of the species which have the testes sufficiently well described to determine their location, *H. breviannulata* (Fuhrmann 1906c) deserves mention. The testes, however, are much smaller, being 0.04 mm in diameter while in the species described above they are about 0.25 mm long and 0.15 mm wide. The ovary is median and although not stated is presumably ventral to the median testes while in our species it is mainly between the two testes on the side away from the pore. The scolex was absent from Fuhrmann's species. The other species which are related to the above described form by having the testes in a transverse row, are all markedly different in the shape and size of the hooks, ovary, and cirrus.

HYMENOLEPIS CUNEATA N. SP.

[Figs. 48-53]

The specimens forming the basis of the description of this species were obtained from a wild duck killed at Table Rock, Nebraska, on June 22, 1896, and are preserved in the collection of H. B. Ward.

Of these specimens the following mounts, consisting of eight totos and five sets of serial sections, numbers 25.14 to 25.20 inclusive, were desig-

nated as cotypes. They remain in the Ward Helminthological Collection at the University of Illinois, Urbana.

External Anatomy. The specimens of this species vary from 30 to 40 mm in length, those of about 30 mm usually lacking eggs in the uterus but have the female organs well developed. The shape of the strobila is peculiar in that the widest part is usually from 3 to 5 mm from the posterior end, and tapers gradually toward the scolex, the general form thus being wedge-shaped. Specimens vary from 3 to 4 mm wide at the widest point and from 0.5 to 1 mm wide at the central part of the strobila. The posterior portion is evenly rounded behind the widest part, and the last proglottid is sterile and much smaller than those immediately in front. Strobilae 30 to 35 mm long have from 200 to 250 proglottids while those about 40 mm long have about 300. The genital pores are unilateral and on the right side of the proglottid. No irregularity in the structure of the genital organs or the general structure of the proglottids has been observed.

The scolex is a strongly developed structure, measuring about 0.35 mm in diameter, and carrying four suckers, each of which are about 0.15 mm in diameter. The rostellum is provided with a sac which occupies about one-third the diameter of the scolex. The rostellum is a solid muscular organ of about the same diameter throughout its entire length, and is not retracted into the rostellar sac as an introvert. It carries from six to eight very sharp and strong hooks arranged in a single row about its distal end. Two specimens were found to possess six hooks, one had seven, and three had eight, so it is evident that the number is by no means constant. The hooks are large enough and placed far enough apart so that there is little difficulty in making an accurate count. They vary in length from 103 to 115μ, the majority measuring from 105 to 108μ; only four were found which measured 112 and 115μ.

The three testes lie in a transverse row in the center of the proglottid and are about equally spaced. They are somewhat oval and measure about 500μ along the transverse diameter of the proglottid, 170μ dorsoventrally, and about 100μ antero-posteriorly in proglottids about 22 mm from the scolex. The larger part of the ovary is found anterior to and on the antiporal side of the middle testes. It occupies the larger part of the central region of the proglottid when fully developed. The vasa efferentia arise on the median side of the two lateral testes and on the dorsal side of the median testes. The ducts from the two poral testes join, and the short common duct thus formed unites with the vasa efferentia from the antiporal testes. The vas deferens soon communicates with the external seminal vesicle at its median end. The latter communicates with the internal seminal vesicle through the slightly coiled remaining portion of the vas deferens, which lies dorsal and anterior to the poral testis. The external seminal vesicle lies dorsal and anterior to the region between the two poral testes.

The cirrus sac lies dorsal to the excretory ducts as does the vagina. A rather large and somewhat dumb-bell shaped internal seminal vesicle occupies about three-fourths of its inner portion and communicates with the cirrus by means of a wide duct. The vas deferens communicates with the internal seminal vesicle at its inner end, which lies against the wall of the sac, and the duct leading to the cirrus arises at the end of the vesicle nearest the pore. The latter passes back alongside the vesicle to the inner enlarged end where it enters the cirrus. The cirrus extends inward about three-fourths the length of the sac and lies along one side of the wall for the greater part of its length. It is usually straight but in some instances is slightly bent or coiled in parts, and is provided with hooks only along its outer portion. The vagina opens ventrally and somewhat posteriorly to the cirrus into the genital atrium. The latter varies much in depth in different parts of the strobila. The total length of the internal seminal vesicle is about 500μ, the width of the inner enlargement 60 to 75μ, and of the outer 50 to 60μ in proglottids about 22 mm from the scolex. The cirrus sac is about 1 mm in length in this region.

The beginnings of the ovary and other female reproductive organs appear in proglottids about 20 mm from the scolex, and are fully developed about 30 mm from the scolex. The ovary is deeply divided into 15 to 20 irregular rounded lobes, and lies anterior and ventral to the median testes occupying the middle one-third of the proglottid. The vitelline gland is likewise lobed and lies in the concavity in the posterior side of the ovary. The ootype is rounded and is located ventral to the vitelline gland.

The vagina opens on a well marked papilla which is ventral and anterior to the opening of the cirrus sac. The two do not usually open on the same level, but the vagina into a deep depression of the genital atrium extending back along the cirrus sac. The lateral portion of the vagina is a narrow duct which lies close to the cirrus sac and the vas deferens until it widens out to form the thin-walled seminal receptacle. The latter is found just beyond the seminal vesicle and about on the same level in young proglottids. The duct leading from it to the region of the female reproductive organs can be traced. As development proceeds, almost the entire median portion of the vagina becomes distended by spermatozoa, forming a very large seminal vesicle extending almost to the excretory vessels, and occupying the larger portion of the central region between the muscular layers in proglottids about 30 mm from the scolex. The seminal receptacle is first evidenced by a slight widening of the duct just beyond the seminal vesicle, and as development proceeds, this widening is found to extend along the duct toward the pore, and in mature proglottids this whole portion of the duct becomes filled with spermatozoa as described above.

The uterus is a sac-like structure, which extends, on either side beyond the excretory vessels, and fills the larger part of the ripe proglottids. It is

deeply divided into irregular lobes by septa. The eggs, in every specimen examined, were found to be very immature, being only rounded or oval masses of cells and showing no shell.

The longitudinal muscles are very well developed and are in two irregular layers on either side of the proglottid. The outer one has the bundles usually of a smaller size than those of the inner, though some are as large as those of the inner layer. No oblique muscle bundles could be located. Two groups of from four to six longitudinal muscle bundles are found on each side of the proglottid, one on either side of the spaces between the testes. Two longitudinal excretory vessels lie on either side of the proglottid, ventral to the vagina and cirrus sac. The larger one is ventral and measures about 50μ in diameter about 20μ mm from the scolex. The smaller one is about 20μ in diameter in the same region, and lies invariably directly dorsal to the larger. A careful examination of these in sections failed to reveal any transverse ducts joining those on opposite sides of the proglottid.

A comparison of this species with others is indeed difficult, because there has been no description found which shows a similar combination of characters. When compared with the other species which have the testes arranged in a transverse row, none are found which show any resemblance to it. Likewise when the hooks are compared, there are no others which have such large ones of a similar shape and number except *H. macracanthos*, v. Linstow 1877, but these are different in that there is no projection on the posterior basal portion. This species was described from an immature specimen and consequently could belong to any one of several genera as pointed out elsewhere in this report.

When the descriptions of the species that have been found in Anseriformes are compared, no one is found which compares with it in size and shape of hooks and arrangement of the internal organs. It seems proper to conclude therefore that this form is an undescribed species.

HYMENOLEPIS SACCIPERIUM N. SP.

[Figs. 40-47]

The material which formed the basis for the following description was taken from the intestine of two specimens of *Marila marila*, American scaup duck, or bluebill, one of which was killed at Peoria, Illinois, November 25, 1923, and the other at Lincoln, Nebraska, April 11, 1908. The specimens from the host taken at Peoria, Illinois, are in the collection of the author under the number 584a, and are designated as cotypes. In the Ward Helminthological Collection at the University of Illinois, Urbana, there are eight mounts, five totos and three sets of serial sections, numbers 25.21 to 25.26 inclusive. These were prepared from the specimens taken at

Lincoln. The type is No. 25.21 in the Ward Collection of Parasites at Urbana.

External Anatomy. The length of specimens which have well developed eggs in the posterior proglottids is about 38 cm. The width increases gradually from 150μ immediately behind the scolex to the greatest width, 1.25 mm to 2 mm, 9 to 10 cm from the scolex. Throughout the greater part of the remainder of the strobila, the width is about the same, but decreases slightly toward the posterior end. The above measurements are for specimen No. 584a3. The proglottids are about 35μ long at about 35 mm from the scolex. They increase to 160μ 60 mm from the scolex, while posterior proglottids with well filled uteri measure 1.7 mm wide by 0.32 mm long in larger specimens. The suckers are 60μ wide, inconspicuous, and but slightly raised above the surface of the scolex.

The scolex is rounded and not conspicuously set off from the neck region behind. It is 0.2 mm wide, while the width of the neck region is about 0.15 mm at its center. The rostellum is short in proportion to the width of the scolex, being about 25μ in length and 60μ wide. The tip of the rostellum is dome-shaped and bears a single row of hooks about its margin. The hooks are from 18 to 22 in number and are from 14 to 17μ long and have the shape indicated by figure 43. The neck region is short, strobilization being evident 1.3 mm behind the scolex by slight constrictions in the surface of the strobila.

The testes are the most conspicuous structures in the entire proglottid. They lie in a transverse row, occupy almost the entire space between the muscular layers, and extend antero-posteriorly almost the full length of the proglottid. The number varies from one to four, about 93 to 95 per cent of the proglottids having three, while in the remainder there are one, two, and four, one being much rarer than any of the other numbers. The arrangement of these with reference to the ovary, vitelline gland and shell gland is likewise very variable; in those proglottids with four testes, three of this number are either on the antiporal side and one on the poral, or two may be on each side, but never three on the poral side; of those having three, two may be on the poral or antiporal side or all three may be on the antiporal side, but never all on the poral; in cases where there are two testes, both may be on the antiporal side, or one may be on either side of the ovary, the latter being slightly more frequent than the former. Proglottids which have one, have this testis on the poral side in the few instances observed. The testes vary much in size and shape in different proglottids, but they are about 0.2 mm in diameter in proglottids while the ovary is about that size. The testes are frequently lobed or deeply constricted usually in the longitudinal axis of the strobila.

The vasa efferentia arise on the anterior, poral side of the antiporal testes and on the anterior antiporal side of the poral testes in those proglottids having three testes. The duct from the farthest antiporal testes

passes anterior and slightly ventral to the median testes and uniting with the one from the latter forming a duct which joins the vas deferens from the poral testes about midway between the poral and the median testes. Considerable irregularity has been observed in these ducts, as is indicated in figure 5, but this seems to be confined to the region where they pass into the vas deferens. These irregularities in the testes occur in the material from both hosts. The vas deferens thus formed then passes to the external seminal vesicle in an almost straight line.

The cirrus sac is about 0.3 mm long and extends medially and anteriorly from the pore which lies about the center of the margin of the proglottid on the right hand side. The internal seminal vesicle occupies about the inner half of the sac, while the cirrus with its attached muscles and associated cells occupies the outer half. The cirrus is a straight tube in most instances but is sometimes slightly coiled. So far as could be observed, it is without hooks. The external seminal vesicle lies anterior to the poral testis and is an elongate structure with thin walls. It is joined to the internal seminal vesicle by a slightly coiled duct. The longitudinal excretory ducts lie beneath the inner end of the cirrus sac and the outer end of the vesicle.

The ovary is a crescent-shaped organ lying usually in the center of the proglottid, but may be somewhat to the right or poral side, when there are three testes on the antiporal side. It is but slightly lobed or indented, and has the somewhat lobed vitelline gland lying in the hollow of the crescent behind. The ootype, and female genital ducts lie between the vitillaria and ovary and somewhat ventral to both. The seminal receptacle is the wide, thin-walled, somewhat coiled portion of the vagina which lies anterior and medial to the poral testes. It is widely distended with spermatozoa in proglottids which have the female organs well developed. The vagina is a wide duct leading from its outer end to its point of opening into the genital atrium ventral to the opening of the cirrus. It lies ventral to and along the posterior side of the external seminal vesicle and ventral to the cirrus sac; in the region of the latter it is usually somewhat bent.

The uterus passes dorsal to the excretory vessels on either side, bends ventrally, passing ventral to the testes, and dorsally again above the ovary, vitelline and shell glands. In the ripe proglottids the uterus occupies almost the entire proglottid. It is slightly lobed or indented on both margins and has the remnant of the seminal receptacle lying in a cavity in its anterior right-hand margin. The number of eggs which the uterus contains varies considerably in different proglottids, some having only a few while others are packed. The eggs were mature in specimens from both hosts, and were essentially the same size. The shells are relatively thick and each of the outer ones were observed to have nuclei within as indicated in figure 42. The middle shell averages 33 by 28μ in size with a maximum length and width of 37 by 32μ, and a minimum of 28 by 12μ. The outer shell was so distorted by shrinkage that scarcely any eggs could be found

which had it well enough preserved for measurement. Its size on the one from which the drawing was made was 40μ in diameter. The embryos possess six slender hooks, and average 28 by 15μ in size. Their maximum length and width is 32 by 18μ and their minimum 16 by 13μ.

There are two pairs of longitudinal excretory vessels running through the lateral portion of the strobila. The ventral vessel on each side is much the larger of the two, being about 53 by 25μ in size about 55 mm from the scolex, being elongated in the transverse diameter of the proglottid, while the dorsal is but about 15μ in diameter in the same region. An examination of the walls reveals no indication of transverse vessels connecting the longitudinal vessels in any part of the proglottid. The longitudinal muscles are but weakly developed, there being approximately 100 bundles on both the dorsal and ventral sides of the proglottid. The oblique muscles are conspicuous and well developed. They lie outside the longitudinal and near the surface of the proglottid.

An examination of the descriptions of the species that are sufficiently complete to state the position of the testes reveals none which are comparable in general characters to the one described above. There is no description in which any detailed reference is made concerning the variations in the number of testes. This characteristic is so noticeable in this species that it seems that it would not have escaped the attention of any one who had examined it.

When the literature descriptive of the species found in Anseriformes is examined, the first species to attract one's attention is *Weinlandia coronula* (Dujardin) 1845, which has 20 to 26 hooks 14 to 19μ long. The hooks are shaped much like those of the species described above, but are somewhat more strongly constructed throughout in all parts. The musculature of the two species is somewhat similar (Wolffhügel 1900) in that the inner longitudinal layer of bundles consists of a relatively few large conspicuous bundles on the dorsal and ventral sides, (six in *W. coronula* and 10 to 12 in our species on either side) and two or three bundles above and below the excretory vessels near the margin of the worm. The cirrus sac, cirrus, external and internal seminal vesicles, and location of the female reproductive organs are very similar. The outstanding difference, however, is found in the position of the testes. Fuhrmann (1906: 733) says that the two antiporal testes are arranged so that one is anterior and median in position with reference to the other, and Meggitt (1920: 307) says that in the extended specimens studied by him, they have this position though in strongly contracted ones the three may lie in a straight line, yet there is always a small projection of the outer testes lying behind the inner so that there is always a distinction into anterior and posterior testes. The other species found in the Anseriformes having the hooks similar in number and length have no resemblance to the above described form in internal structure. It seems justifiable, therefore, to designate this form as a new species.

GENUS WEINLANDIA NOV. GEN.

Three testes in a proglottid, two located on the posterior border and the third directly anterior, anterior and median, or anterior and lateral to the antiporal posterior testis. Rostellum generally well developed and armed or unarmed. Vas deferens with an internal and an external seminal vesicle. Genital ducts dorsal to the longitudinal excretory vessels or exceptionally between or below. Pores unilateral.

Type species: *Weinlandia macrostrobilodes* n. sp.

LIST OF THE SPECIES OF WEINLANDIA

Two testes posterior, the third anterior and lateral to the posterior antiporal testis.

1. *Weinlandia arcuata* Kowaleski 1905.
   See Kowaleski 1905: 222-238; 1905a: 532-533 (Figs. 1-9).
2. *Weinlandia cyrtoides* n. sp.
   See this paper, p. 59.
3. *Weinlandia abortiva* von Linstow 1904.
   See von Linstow 1904a: 383 (*Hymenolepis voluta*): 1905: 362.
4. *Weinlandia chionis* Fuhrmann 1921.
   See Fuhrmann 1921: 517-518 (Figs. 110-113).
5. *Weinlandia collaris* (Batsch 1786) Fuhrmann 1908.
   See Stiles 1896: 40-41 (Figs. 116-146) (*Drepanidotaenia sinuosa*). Cohn 1901: 323-325 (*Hymenolepis sinuosa*).
6. *Weinlandia diorchis* Fuhrmann 1913.
   See Fuhrmann 1913: 29-31 (Figs. 21-25).
7. *Weinlandia farciminosa* (Goeze 1782).
   See Krabbe 1869: 321-322 (Figs. 230-232) (*Taenia farciminalis*). Volz 1900: 32-35 (Fig. 10) (*Diplacanthus farciminalis*).
8. *Weinlandia flagellata* Fuhrmann 1906.
   See Fuhrmann 1906b: 356-357 (Figs. 8-9).
9. *Weinlandia globocephala* Fuhrmann 1918.
   See Fuhrmann 1918: 443-445 (Figs. 64-66).
10. *Weinlandia gracilis* (Zeder 1803) Cohn 1901.
    See Stiles 1896: 38-39 (Figs. 80-99) (*Drepanidotaenia gracilis*); Wolffhügel 1900: 176-183 (Figs. 106-109) (*D. gracilis*); Cohn 1901: 327-329; Clerc 1903: 305-306 (*D. gracilis*).
11. *Weinlandia glandularis* Fuhrmann 1909.
    See Fuhrmann 1909: 43-44 (Fig. 42).

12. *Weinlandia jaegerskioeldi* Fuhrmann 1913.
See Fuhrmann 1913: 25-26 (Figs. 15-17).
13. *Weinlandia longirostris* (Rudolphi 1809).
See Krabbe 1869: 293; Fuhrmann 1906: 733.
14. *Weinlandia microsoma* (Creplin 1829) Cohn 1901.
See Krabbe 1869: 296-298 (Figs. 146-150) (*Taenia microsoma*); Cohn 1901: 284-288 (Figs. 15-22); Fuhrmann 1913: 23 (Figs. 12-14).
15. *Weinlandia meleagris* (Clerc 1902) Fuhrmann 1906.
See Clerc 1902a: 574-575; 1903: 306.
16. *Weinlandia megalops* (Nitzsch in Creplin 1829) Parona 1899.
See Ransom 1902: 158-167 (Figs. 11-14).
17. *Weinlandia lateralis* n. sp.
See this paper, p. 56.
18. *Weinlandia papillata* Fuhrmann 1906.
See Fuhrmann 1906b: 357-358 (Figs. 10-11).
19. *Weinlandia parvula* Kowaleski 1905.
See Kowaleski 1905a: 533-534 (Figs. 10-17).
20. *Weinlandia rara* Skrjabin 1914.
See Skrjabin 1914: 468.
21. *Weinlandia stylosa* (Rudolphi 1810) Volz 1899.
See Krabbe 1869: 326 (Figs. 242-244) (*Taenia stylosa*). Volz 1900: 141-144 (Fig. 9) (*Diplacanthus stylosus*).
22. *Weinlandia styloides* Fuhrmann 1906.
See Fuhrmann 1906: 354 (Figs. 3-5).
23. *Weinlandia sphenocephala* (Rudolphi 1809).
See Fuhrmann 1906: 449 (Figs. 34-35).
24. *Weinlandia serpentula* (Schrank 1788) Weinland 1858.
See Volz 1900: 135-140 (Fig. 8) (*Diplacanthus serpentulus*); Cohn 1901: 294-297 (Figs. 23-25); Clerc 1903: 295-296 (Fig. 8) (*Drepanidotaenia serpentulus*).
25. *Weinlandia tritesticulata* Fuhrmann 1906.
See Fuhrmann 1907a: 531-532 (Figs. 34-36).
26. *Weinlandia teresoides* Fuhrmann 1906.
See Fuhrmann 1906c: 443-444 (Fig. 20).
27. *Weinlandia vaginata* Baczynska 1914.
See Baczynska 1914: 214-218 (Figs. 49-50).

Two testes posterior, the third anterior to the antiporal posterior testis.

28. *Weinlandia annandalei* Southwell 1922.
See Southwell 1922: 374-377 (Figs. 10-13).
29. *Weinlandia amphitricha* (Rudolphi 1819) Fuhrmann 1906.
See Krabbe 1869: 311-312 (Figs. 195-197) (*Taenia amphitricha*); Clerc 1903: 293-295 (Fig. 21) (*Drepanidotaenia amphitricha*).

30. *Weinlandia brevis* Fuhrmann 1906.
See Fuhrmann 1906e: 753-754 (Fig. 22).
31. *Weinlandia columbina* Fuhrmann 1909.
See Fuhrmann 1909: 41-42 (Fig. 38-40).
32. *Weinlandia caroli* Parona 1887.
See Fuhrmann 1906e: 741-743 (Fig. 3-7).
33. *Weinlandia carioca* (Magalhaes 1898) Ransom 1902.
See Ransom 1902: 151-158 (Fig. 1-10); 1905: 274-276 (Figs. 3, 10,22, 28); Guberlet 1919: 35-38.
34. *Weinlandia corvi* n. sp.
See this paper, p. 62.
35. *Weinlandia interrupta* (Rudolphi 1802) Fuhrmann 1906.
See Fuhrmann 1906e: 745-746.
36. *Weinlandia intermedia* Clerc 1906.
See Clerc 1906: 436 (Figs. 7-9).
37. *Weinlandia inflata* (Rudolphi 1809).
See Cohn 1901: 330-331.
38. *Weinlandia importata* Fuhrmann 1918.
See Fuhrmann 1918: 447-449 (Fig. 75-78).
39. *Weinlandia ibidis* Johnston 1911.
See Johnston 1911: 88 (Figs. 22-24).
40. *Weinlandia liguloides* (Gervais 1847).
See Fuhrmann 1906e: 741-745; Cohn 1901: 271-277 (Figs. 1-5).
41. *Weinlandia lobata* Fuhrmann 1906.
See Fuhrmann 1906b: 352-353 (Fig. 1).
42. *Weinlandia megalorchis* Lühe 1898.
See Cohn 1901: 277-280 (Fig. 6-12).
43. *Weinlandia medici* (Stossich 1890) Fuhrmann 1906.
See Fuhrmann 1906e: 749-750 (Figs. 14-16).
44. *Weinlandia microscolecina* Fuhrmann 1906.
See Fuhrmann 1906e: 740.
45. *Weinlandia magniovata* Fuhrmann 1918.
See Fuhrmann 1918: 445-447 (Figs. 68-72).
46. *Weinlandia octacantha* (Krabbe 1869) Fuhrmann 1906.
See Krabbe 1869: 301 (Fig. 162) (*Taenia octacantha*); Fuhrmann 1906e: 746-747 (Figs. 9-10).
47. *Weinlandia phasianina* Fuhrmann 1907.
See Fuhrmann 1907a: 533-534 (Figs. 40, 41).
48. *Weinlandia passerina* Fuhrmann 1907.
See Fuhrmann 1907a: 533 (Fig. 39).
49. *Weinlandia parina* Fuhrmann 1907.
See Fuhrmann 1907a: 534 (Fig. 42).
50. *Weinlandia pellucida* Fuhrmann 1906.
See Fuhrmann 1906c: (Figs. 12-13).

51. *Weinlandia planestici* n. sp.
See this paper, pp. 73-75.
52. *Weinlandia rostellata* (Abildg. 1793).
See Fuhrmann 1895: 443-449 (Fig. 5-10) (*Taenia capitellata* Rud.)
53. *Weinlandia simplex* Fuhrmann 1906.
See Fuhrmann 1906e: 753 (Figs. 20-21).
54. *Weinlandia tetracis* Cholodkovsky 1906.
See Cholodkovsky 1906: 338-339 (Figs. 18-21).
55. *Weinlandia tubicirrosa* Baczynska 1914.
See Baczynska 1914: 217-218 (Figs. 49-50).
56. *Weinlandia tenuis* Clerc 1906.
See Clerc 1906a: 536-537 (Figs. 19-21) (*Echinocotyle tenuis*).
57. *Weinlandia uncinata* Fuhrmann 1906.
See Fuhrmann 1906c: 441 (Figs. 14-15).
58. *Weinlandia zosteropis* Fuhrmann 1918.
See Fuhrmann 1918: 441-443 (Fig. 59-63).

Two testes posterior, the third anterior and median to the antiporal posterior testis.

59. *Weinlandia armata* Fuhrmann 1906.
See Fuhrmann 1906b: 353-354 (Fig. 2).
60. *Weinlandia coronula* (Dujardin 1845) Cohn 1901.
See Krabbe 1869: 317-318 (Figs. 216-219) (*Taenia coronula*); Stiles 1896: 33 (Figs. 21-28) (*Dicranotaenia coronula*); Wolffhügel 1900: 165-175 (Figs. 97-105) (*Dicranotaenia coronula*); von Linstow 1905: 5 (Figs. 16-18) (*H. megalhystera*), Fuhrmann 1906e: 733; Meggitt 1920: 307-308 (Figs. 1-2).
61. *Weinlandia introversa* n. sp.
See this paper, pp. 67-70.
62. *Weinlandia interrupta* Clerc 1906 (Name preoccupied, see 35 above).
See Clerc 1906: 435 (Figs. 5-6). Also listed as 68 below.
63. *Weinlandia macrostrobilodes* n. sp.
See this paper, pp. 65-67.
64. *Weinlandia microps* (Diesing 1850) Fuhrmann 1906.
See Wolffhügel 1900: 191-192 (Fig. 110); Fuhrmann 1906e: 733.
65. *Weinlandia querquedula* Fuhrmann 1913.
See Fuhrmann 1913: 515-517 (Figs. 103-109).

Two testes posterior, the third anterior to but varying from a lateral to a median position with reference to the antiporal posterior testis.

66. *Weinlandia asymetrica* Fuhrmann 1918.
See Fuhrmann 1918: 439-441 (Fig. 53-58).

67. *Weinlandia microcirrosa* n. sp.
See this paper, pp. 70-72.
68. *Weinlandia interrupta* Clerc 1906
See Clerc 1906: 435 (Figs. 5-6). Also listed as 62 above.

DESCRIPTIONS OF NEW SPECIES

WEINLANDIA LATERALIS N. SP.

[Figs. 55-62]

The specimen which forms the basis of this description was collected by the writer at San Juan Island, Washington, July 7, 1923, from the intestine of *Larus glaucescens* Naumann, glaucus-winged gull, and is preserved in the author's collection under the No. 277.1. Its length is 25 cm and its greatest width 1.6 mm. The anterior portion is very much attenuated, the width just back of the scolex being 100μ, while 100 mm behind it is but 136μ. From this point on, it rapidly increases in size as is indicated by the following measurements: 60 mm from the scolex 220μ, 100 mm from the scolex 765μ, and near the posterior end 1.6 mm in width. There is scarcely any neck since the slight constrictions indicating the beginning of strobilization are evident immediately behind the scolex. The length of the anterior proglottids about equals the width, but after the sex organs begin to develop, the width rapidly increases in proportion to the length, as is indicated by the following figures: at 40 mm behind the scolex the length about equals the width, namely 136μ, at 60 mm behind the scolex where the width is 220μ, the length is 170μ; at 100 mm, width 765μ, length 255μ; and in the posterior portion where the width is 1.6 mm, the length is 0.5 mm. The genital pores are unilateral and on the right side in all portions except at a point about 60 mm from the scolex where there are two proglottids which have the pores on the opposite side.

The scolex is but little wider than the anterior end of the strobila, and with the suckers, measures but 160μ in diameter. The suckers are round and measure 75μ with an opening 50μ in diameter. The rostellum, which is fortunately fully extended in the single specimen obtained, is relatively large when compared with the scolex proper. It is 250μ long with a width at the narrowest part of 26μ, and at the distal end of 47μ. The distal end is somewhat dome-like in shape and carries eight hooks which have a shape like figure 55 and which are 26 to 30μ in length. A little below its center the rostellum has a slight constriction which suggests that this is the point to which it is retracted.

The three testes are all on the poral side of the proglottid, the two nearest the pore are dorsal and on the posterior margin, while the third is somewhat anterior to the median testes and in front of the ovary. The latter is also usually more ventral in position than the other two. Occasion-

ally proglottids appeared to have four testes in toto mounts, but none were observed in sections to have more than three. Testes are often observed to be lobed in sections and this is believed to account for the appearance of four of these organs in toto mounts. The testes are oval or spherical in shape. They measure about 200μ in length by about 80μ in width in proglottids 120 mm from the scolex.

The vasa efferentia arise on the sides of the testes nearest the external seminal vesicle, and are very slender ducts. Those from the two antiporal testes unite forming a common duct which is soon joined by the duct from the other testes. No irregularities in the vasa efferentia were observed, although it is not at all unlikely that such occur since the organs are so closely packed together in that region it is very difficult to get any clear idea of their arrangement in many proglottids. The vas deferens, thus formed, is short and soon empties into the external seminal vesicle on its inner margin. The external seminal vesicle is a relatively thin-walled sac which lies just in front of, partly dorsal, or partly ventral to the antiporal testis, and communicates with the cirrus sac through a very small pore. The cirrus sac is one of the most conspicuous structures of the proglottid. It extends about half way across the proglottid and has a well developed retractor muscle extending from its inner end to the wall of the proglottid. Two portions are easily distinguishable, even in toto mounts; the innermost portion contains the internal seminal vesicle and the outer portion contains the cirrus. The internal seminal vesicle is rounded and is dividied by partial septa into several almost complete divisions varying in number up to six. These septa seem to disappear as the vesicle becomes enlarged toward maturity, since they are less numerous and even none are present in the proglottids with well developed female organs.

The cirrus is almost straight but is usually more bent and curved along its inner portion than along the outer. The inner portion is also sometimes expanded into a seminal vesicle-like structure. The inner walls of the outer portion especially are thickly set with stout spines. The cirrus sac opens dorsal to the opening of the vagina, and on the right side of the proglottid. Sections at about 100 mm from the scolex show a direct connection between the cirrus sac and the vagina suggesting that self-fertilization is at that time possible (Fig. 59). However, there are no spermatozoa evident at this time and in fact, there is considerable doubt if any are present in the entire strobila. On the other hand, there are numerous eggs undergoing development, as well as single-celled ova, in the uterus of ripe proglottids, which suggests parthenogenesis. In proglottids with well developed female organs there is no genital atrium as the two pores lie side by side on the surface at the border of the proglottid.

The vagina, like the cirrus sac, is a conspicuous organ, reaching about one-third the width of the proglottid or about to the inner end of the cirrus.

The wall of the outer portion is relatively thick, and its inner portion bends ventrally somewhat just medial to the excretory vessels, being rounded and somewhat enlarged. It, like the cirrus sac, passes dorsal to the excretory vessels, and its opening is ventral to that of the cirrus. The median portion of the vagina is a small, somewhat curved duct which passes from the rounded inner end of the thick-walled portion described above, ventral to the testes and dorsal to the ovary to the region behind the antiporal testes where it abruptly enlarges, forming a thin-walled seminal receptacle. A small duct leads ventrally and laterally to its place of union with the oviduct.

The ovary is deeply divided into eight to twelve finger-like lobes, and lies in the posterior left hand portion of the proglottid. The vitelline gland is likewise deeply lobed, and lies in the concavity in the posterior side of the ovary, while the shell gland is rounded and ventrally placed beneath the vitelline gland. The uterus passes dorsal to the excretory vessels on both sides, and dorsal to the ovary, but ventral to the testes. Its start is found in proglottids about 100 mm from the scolex where its course may be traced by a strand of deeply staining cells. In mature proglottids the uterus extends almost to the margins of the proglottids, and is deeply divided into about a dozen irregular lobes. The eggs are immature. They only consist of an oval mass of cells with readily staining nuclei and a clearly defined outer shell. The shell of the largest egg measured was 21 by 16μ in size, while the smallest was 16 by 12μ. The size of the largest embryo was 16 by 12μ, while the smallest was 10 by 11μ.

There are two excretory vessels on either side of the strobila, a large ventral one which measures about 75μ in diameter at about 100 mm from the scolex, and a small dorsal one about 15μ in diameter in the same region. In the anterior and posterior portions of the proglottids, they lie in the central part of the parenchyma about 150μ from the margin. Those on the poral side, however, are displaced ventrally in the central portion of the proglottid by the large cirrus sac and vagina. No connecting vessels could be located in either transverse or frontal sections. The longitudinal muscles are in two layers, each of which contains about 30 bundles on each side of the proglottid. The bundles are very variable in size but those of the inner layer are in general, although not always, larger than those of the outer.

This specimen seems to be unique when the literature is examined with reference to the arrangement of the testes and ovary. *H. ardeae* Fuhrmann (1906: 451) has the three testes in a transverse row on the anterior side of the proglottid and the ovary on the side away from the pore beyond the farthest testis. *H. elongata* Fuhrmann (1906: 450) has the three testes in a transverse row on the poral side but in the posterior portion. The following species are similar to the above described species in that the three testes

are all on the poral side of the proglottid: *H. setigera* (Frölich) 1789, *H. venusta* Rosseter 1897, *H. bilateralis* v. Linstow 1905, and *H. lanciolata*, but no one of them has the antiporal testes placed toward the anterior border of the proglottid.

Fuhrmann (1908) lists four species of Hymenolepis as occurring in Lariformes. *H. fusa* was described by Krabbe (1869: 307) from *Larus glaucus* from Greenland and *Larus ridibundus* from Bavaria. He records the length as being 250 mm, width 1 mm, 10 hooks 15 to 17μ long, and a few other external details, but as is often characteristic of his descriptions, nothing of the internal structure is given. No record has been found of a restudy of the material, but this could not be our species, since the hooks are only about one-half as long and entirely different in shape. *H. baschkiriensis* Clerc 1902, from *Larus canus*, has hooks 73μ or more than twice as long as our species, and the cirrus sac is much smaller, being only about one-tenth the width of the proglottid, while in the one described above, it is at least one-half the width. *H. octacanthoides* Fuhrmann 1906 has the testes arranged as in the above description but the ovary and shell gland in the center of the proglottid and anterior to the testes. The fourth species recorded from this group of birds is *Weinlandia microsoma* which has the testes arranged similar to the above, but the ovary occupies the entire posterior portion of the proglottid ventral to the testes, as described by Cohn (1901: 284). There are ten hooks about twice the size of the *W. lateralis*.

WEINLANDIA CYRTOIDES N. SP.

[Figs. 85-90]

The material which formed the basis of the following description was obtained from the intestine of *Erismatura jamaicensis*, the Ruddy duck, at Peoria, Illinois, on November 26, 1923. These small cestodes were present in large numbers (about 200) in the single host from which they were obtained. They are preserved in the author's collection under the number 576b.

External Anatomy. This interesting little cestode is from 3 to 10 mm in length, depending upon the stage of maturity and the state of contraction of the specimens. The scolex and rostellum are relatively large for the size of the strobila. The rostellum is about 80μ long with a knob-like distal end 60μ in diameter, and a nrrower middle portion 35μ long. The scolex is about 0.15 mm wide, and has four rounded suckers about 70μ in diameter. The rostellum is armed with eight large dagger-like hooks (Fig. 86), 67 to 70μ in length. It is retracted as a solid muscular body and does not seem to be drawn into a sac but only capable of being drawn down toward the scolex, the points of the hooks being drawn down close to its surface.

Strobilization begins about 0.07 to .1 mm behind the scolex and very soon the strobila is well marked off into distinct proglottids. The proglottids are about 0.07 mm wide at the narrowest part behind the scolex; in the region of the thirtieth proglottid about 0.15 mm; at the fiftieth, 0.2 mm; at the sixtieth, 0.4 mm; and at the eighty-fifth, about 0.4 mm. The number of proglottids in a strobila is about 100, the last one is always sterile. The uterus can be found in about the eightieth proglottid, and from there on gradually increases until in the more posterior ones it occupies almost the entire interior. The beginnings of the testes can be made out in the region of the fiftieth proglottid, and the ovary in about the seventy-fifth. The strobila is usually more or less curved toward the poral side of the chain, depending upon the amount of contraction, due to the unsymmetrically developed ovary and uterus. It may be bent so much that the posterior end extends across the middle of the chain in cases of extreme contraction.

The three testes are placed so that two of them are on the posterior side of the proglottid and the other in front of the antiporal posterior testes. The position of the anterior antiporal testes varies considerably, but in young proglottids it is invariable anterior and lateral to the posterior antiporal testes. As the cirrus sac increases in size, it and the mesenchyme surrounding it is usually pushed backward so that the three lie in a transverse row. Occasionally a proglottid is found in which it is ventral to the inner end of the cirrus sac and anterior and lateral to other antiporal testes. Still more rarely it lies directly in front of the latter. One proglottid has been found in which only two testes could be identified in a toto mount. The cirrus sac is the first internal organ to appear in the young proglottid, and it shows as a large transverse group of deeply staining cells in the central portion. This develops into the internal seminal vesicle and the inner portion of the sac. Differentiation gradually proceeds outward until the poral side of the proglottid is reached. The walls of the sac are very thick at first and consist of long columnar or almost cuboidal cells which stain very deeply with Ehrlich's acid hematoxylin. As the internal seminal vesicle becomes filled with spermatozoa, these cells gradually lose their staining properties and decrease in size so that the vesicle becomes a thin-walled sac when completely filled with spermatozoa. The internal seminal vesicle, when thus filled, occupies the larger part of the cirrus sac, and has the cirrus attached at its outer end. The cirrus lies along side the internal seminal vesicle (Fig. 88), where it is variously coiled, and finally passes outward to its point of opening upon the surface of the copulatory bulb. The latter is a structure which first appears in young proglottids as a rounded bulb inside the genital atrium, but in old proglottids is found extended through the widely distended pore into a cone-shaped structure from the tip of which the cirrus is extruded. In young proglottids its surface appears to be roughened by circular folds of the clear outer layer.

These are not found in the fully extended structure, and seem to be merely a folding in the outer surface to accommodate the large surface to the small space. The cirrus itself is entirely smooth. The pore is on the right hand side of the proglottid. The inner end of the internal seminal vesicle is connected with the external seminal vesicle by a narrow, thin-walled coiled duct. The external seminal vesicle is large, and extends medially and posteriorly into the central portion of the proglottid.

The first trace of the ovary can be recognized early as a centrally-placed deeply-staining group of cells. As it becomes mature, it comes to lie in two parts, the larger portion consisting of two or three large rounded lobes in the antiporal side of the proglottid and a much smaller poral portion which is generally not lobed. The large antiporal portion may extend considerably beyond the longitudinal excretory vessels, and occupies most of the that side of the proglottids. The vagina opens into the genital atrium, beside the copulatory bulb behind or slightly under the cirrus, and extends medially along the cirrus sac or somewhat beneath. It is a very difficult organ to find on account of its slight differentiation from the surrounding cells, but it may be located even in some proglottids in toto mount. The uterus appears in the region of the eightieth proglottid and rapidly becomes filled with developing ova. In the posterior proglottids, it is widely distended, occupying almost the whole of the posterior of the proglottid, and is generally somewhat larger in the antiporal side than the poral side of the proglottid. This asymmetrical development of the ovary and of the uterus causes the strobila to bend toward the pore side when the muscles strongly contract.

The ova are immature, having but an outer shell, the inner probably being present in some. There are no hooks present. The shell is filled with a loose cellular mass surrounding the embryo which apparently breaks down as maturity is reached. The size of the shell of the largest egg measured was 35μ long and 23μ wide, while the largest embryo was 30 by 14μ in size. The smallest shell was 28 by 19μ and the smallest embryo 21 by 14μ. The excretory ducts are ventral to the genital ducts, the larger one is about 5 by 12μ in diameter, while the smaller 5μ in diameter in proglottids where the beginnings of the testes and cirrus sac are well differentiated. They are so crowded and flattened by the excessively developed reproductive glands and organs in the posterior proglottids that they are difficult to identify in cross sections. The longitudinal muscles are well developed, the bundles are about all the same size and the layers are very irregular.

From the records of specimens which have the testes similarly placed, it is a little difficult to decide to which pattern *W. cyrtoides* belongs because of the many incomplete descriptions. It was stated that in the young proglottids the testes were invariably arranged two posteriorly, one on

each side of the ovary and the other anterior and lateral to the antiporal testes, but in ripe proglottids they usually were found in a nearly transverse row due to the greatly enlarged cirrus sac. Among those which have the testes arranged in a transverse row, one poral and two antiporal, there are none which have a similar combination of internal characters and hook size and shape that are found as described above. In the group having the testes arranged two posterior and the other anterior and lateral on the antiporal side, *Weinlandia diorchis* Fuhrmann (1913) from *Somateria mollissima* has hooks that are somewhat similar in shape and length, but the basal portion is much longer in proportion to the blade than in that described above. This species is interesting in that the anterior antiporal testes is small and produces no spermatozoa.

Among those species of Hymenolepis which have been found in Anseriformes, the following deserve mention. *H. trifolium* v. Linstow 1905 has three very small testes located near one another in the center of the proglottid, a cirrus sac reaching only about one-half the width of the proglottid and hooks with a much shorter blade in proportion to the length of the base. *H. macrocephala* Fuhrmann 1913 has hooks 57 to 63μ while those of this species are about 70μ; there the blade and base are about equal in length while in the above described form the blade is much longer than the base. The other worm is also 3.5 to 4 cm long while the specimen described above is but 3 to 10 mm in length. *Weinlandia gracilis* (Zeder) 1803 has the testes arranged much according to the plan of the above description, but they are much larger and the total length of the specimen is 27 cm. The remaining species found in Anseriformes are all much different in internal structure and shape and size of hooks. It seems proper to conclude, therefore, that this species is new. Another species, which is described as bent toward one margin is *Weinlandia arcuata* Kowalewski 1904, a species which has the same general plan of testes arrangement as that herein described, but the cirrus sac and other organs very unlike as well as the hooks. One margin is described as shortened, resulting in the entire worm being bent somewhat ring-like. That the internal structure is the reason for this is not apparent as the organs are symmetrically figured.

WEINLANDIA CORVI N. SP.

[Figs. 79-84]

The material which formed the basis of the following description was taken from the anterior one-half of the intestine of the common crow, *Corvus brachyrhynchos*, one host being killed on each of the following dates, May 2. Nov. 3, and 10, 1923, at Monticello, Ill. It is preserved in the author's collection under the numbers 203b, 499b, and 531a.

The specimens of this species are from 30 to 62 mm in length, depending on the maturity of the specimens. Specimens having widely extending

uteri filled with ova are about 60 mm long and 0.8 mm wide at the widest point. Proglottids about 25 mm behind the scolex are about 340μ wide, 40 mm behind are about 0.7 mm wide, while at the posterior end of the chain they are about 0.8 mm wide. The length and width, of course, varies greatly with the stage of contraction. The various reproductive organs are well developed in following regions; testes 30 mm, ovary 40 mm, and the uterus is well formed at about 50 mm from the scolex. The genital pores are strictly unilateral, and on the right hand side of the proglottids. The scolex is sharply set off from the strobila by being about three times as wide as the strobila immediately behind, it being about 0.15 mm wide when the suckers are well extended, while the strobila just behind it is 0.05. The suckers are rather prominent when extended but when contracted are inconcpicuous and extend scarcely above the surface of the scolex. They are 0.08 mm in diameter on the scolex from which figure 80 was drawn. The rostellum has not been observed in the extended condition, all being more or less retracted. It is retracted as a solid body and not as an introvert as is indicated by the position of the hooks which are outlined in figure 80. There are eight to ten long slender characteristically shaped hooks (Fig. 82). They are 33 to 36μ in length. The basal part is very long as compared with the blade and is usually almost straight but may be either straight or more or less curved.

Two of the three testes are placed on the antiporal side of the proglottid and one in front of the other. The anterior one is usually directly in front of the posterior, but may be lateral, no instance has been observed where it is medial. The poral testes is in the posterior portion of the proglottid in a line with the posterior antiporal one. The vasa efferentia of three proglottids sectioned frontally from the same specimen are shown in figure 4. From these outlines it is observed that they are irregular. The cirrus sac extends considerably beyond the longitudinal excretory vessel. The internal seminal vesicle is relatively small although it occupies somewhat more of the interior of the pouch when fully distended with spermatozoa than is indicated in the early stages (Fig. 83). From its outer end, the cirrus extends in an almost straight line to the opening into the genital cloaca, dorsal to the opening of the vagina. The walls of the cirrus sac and internal seminal vesicle are relatively thick and in some worms the interior contains much loose connective tissue around the vesicle. The genital cloaca is relatively deep.

The external seminal vesicle is found in the central anterior portion of the proglottid in front of and partially dorsal to the ovary. Its connection with the internal vesicle is through a straight or slightly coiled duct. Well developed testes are to be found in proglottids about 30 mm from the scolex while their first traces are seen much farther anterior to this. The internal end of the cirrus sac is to be found in very young proglottids.

The ovary is found to be well developed about 35 mm from the scolex, while its start is easily made out 10 mm farther forward. It is divided indistinctly into two portions by being narrower in the region just anterior to the vitellarium. The antiporal portion is somewhat larger and is sometimes slightly lobed, while the poral portion is not lobed or very indistinctly so. The vitelline gland is ventral and somewhat posterior to the ovary and lies about in the center of the proglottid. The vagina opens ventral to the cirrus, and is a wide tube with large irregular shaped cells in its walls. It widens out rapidly medial to the cirrus sac and in old proglottids is found to be a wide sac dorsal to the ovary and completely filled with spermatozoa. The vagina and cirrus sac pass dorsal to the nerve and excretory vessels and the pore is always on the right hand side of the proglottid. The uterus in the posterior proglottids extends well out to the border, but occupies the posterior portion only since the large cirrus sac and external seminal vesicle lie in the anterior portion. The eggs were not found to be mature in any specimen examined. In well preserved material they were only oval or rounded masses of cells with nuclei of varying sizes. In some proglottids the uterus is almost divided into two lateral portions by the large central seminal receptacle. The longitudinal excretory ducts are relatively large and conspicuous, the large ventral one being 50 by 20μ and the smaller 10μ in diameter in proglottids about 30 mm from the scolex. The longitudinal muscles are irregular in their arrangement, there being numerous small bundles in the dorsal and ventral portions of the proglottids.

In a discussion of the literature descriptive of cestodes with structures similar to this, the following species deserve mention. In the group of species which have a similar arrangement of testes is *H. arcuata* Kowalewski 1904; here the anterior antiporal testes, however, is lateral to the posterior, the cirrus much smaller, and the hooks, although somewhat similar in shape, are only about half as long as in the above described species. *W. importata* Fuhrmann 1918 has the hooks very slender and with a short blade but with almost no posterior basal portion, the cirrus sac very small and not reaching the excretory ducts, and the two antiporal testes arranged so that the anterior one is lateral to the posterior. *W. interrupta* Fuhrmann (1906: 745) has the position of the two antiporal testes described as being one before the other but not otherwise specific. The hooks have a small blade and small posterior basal portion like in the above described species, but the anterior basal portion is much thicker and stronger. Their length is 27μ, somewhat under those described above, and the host belongs to the Charadriformes, while the crow belongs to the Passeriformes. *W. zosteropis* Fuhrmann (1918: 441) from *Zosterops minuta*, has many similarities, but yet some rather important differences. The cirrus sac is longer and narrower when the figures of ripe proglottids are compared. The ovary is narrower, and considerably lobed, while in the above described form there

are but few lobes. The testes are smaller (50 to 60μ in diameter as compared with 100μ in the above species) and the anterior basal portion of the hooks is much larger than in the species described above.

When the literature is examined with reference to the species of Hymenolepis found in Passeriformes, *W. pellucida* has a somewhat similar arrangement of the testes, but the poral is widely separated from the antiporal, and the hooks, although of a similar length, are not alike in shape. *W. magniovata* Fuhrmann 1918 has hooks similar in length but not similar to those described above in shape, and the internal structure of the proglottid is very different in that the testes are smaller and widely separated from each other. It seems, therefore, proper to conclude that the species described above is new.

WEINLANDIA MACROSTROBILODES N. SP.

[Figs. 63-71, 78]

The specimens forming the basis of the following description of this species were taken from the intestine of *Anas rubripes*, the black duck, one host being taken at Monticello, Illinois on November 3, 1923 and another at Beardstown, Illinois, on November 1, 1923. The parasites are preserved in the author's collection under the numbers 498a and 488a.

The length of worms with fully developed uterus is about 15 cm, while the greatest width is 2 to 2.5 mm. The strobila is very slender immediately behind the scolex, being usually less than half a millimeter wide, but rapidly increases beyond the 10 mm point to a maximum 25 mm behind the scolex. The shallow constrictions marking off the proglottids begin to appear about half a millimeter behind the scolex, consequently there is almost no neck. In the older proglottids the posterior border overlaps the anterior portion of the next proglottid a short distance depending upon the state of contraction of the specimen. The genital pores are marginal, on the right hand side, and somewhat in front of the center of the proglottid.

The scolex is relatively very small when compared with the total length and width of the worm. It is about 125μ, or but little more than 0.1 mm in diameter in the expanded condition. The rostellum is, on the other hand, rather large in proportion to the scolex. It is about 60μ long and 50μ in diameter at the distal end. The distal portion is somewhat enlarged, and carries a crown of 20 or 21 small hooks. Of the four scolices obtained, the rostellum of one of these had 20 hooks, two of the others had 21, while the fourth was contracted in such a manner that the hooks could not be counted with certainty. The hooks are of the shape indicated in figure 65 and are 15 to 16μ in length. The rostellum is retracted into the somewhat shallow rostellar sac as a solid body. The suckers are conspicuous, strongly developed structures with a diameter of about 70μ when expanded. The opening is about 40μ in diameter. They are unarmed.

In the male system two of the three testes lie on the posterior side of the proglottid, one on each side of the ovary and vitelline gland. The other testis is anterior and median to the antiporal testes. In an examination of 340 proglottids to determine the regularity of the testes, eight were found which either had less than three testes or an abnormal arrangement. One of these proglottids had two testes on the poral side and one on the antiporal, all in a transverse row, which is suggestive of an ancestral condition in which there were two or more testes on the poral side, while the occurrence of but one on the poral suggests that possibly the two regularly found there have united. In another there are three on the poral side, two of which are much smaller, suggesting that these have not united. The vasa efferentia arise on the median border of the testes and pass medially. Those from the two antiporal testes usually join, forming a common duct which soon unites with the one from the poral testes just median to the seminal receptacle. The vas deferens, thus formed, is a straight tube, and passes anteriorly and laterally near the median wall of the seminal receptacle to the end of the seminal vesicle. The vasa efferentia were found to be somewhat irregular in their arrangement, as will be seen by examining figures 2 and 3. In some proglottids and in one worm in particular from which their arrangement is shown in 7 consecutive proglottids in figure 2, the vasa efferentia are very irregular. From these, it may be observed that the three main efferentia unite usually as described above, that is, the two from the antiporal testes join before uniting with the poral duct, but in proglottid e, they all three unite at the same point. The number of ducts from a single testes is also seen to be very variable, there being from one to four. In another specimen, the manner of joining of the ducts was found to be irregular, but in the few proglottids that were sectioned, no other irregularities were observed.

The seminal vesicle is about 0.25 mm long in proglottids 65 mm from the scolex, it having increased from a slender, deeply staining tube in the anterior proglottids to a widely expanded, elongate bulb with the sexual development and the production of the spermatozoa. Its lateral end reaches to the longitudinal excretory vessels, and is joined with the cirrus sac by a slender duct which passes dorsal to the latter and makes one to four coils in the course of this short distance.

The cirrus sac reaches to the longitudinal excretory vessels and is about 3 mm long. A large internal seminal vesicle occupies about half of its length, and early becomes filled with spermatozoa. The cirrus is a very slender thin-walled tube which can only be traced with high magnifications. Its inner portion and sometimes well out to the outer end, has wavy walls which at the narrow places leave only a very narrow lumen. The outer portion has its wall set with very fine spines.

In the female system the ovary is placed somewhat ventrally and in the posterior half of the proglottid. It consists of about ten slender

lobes directed anteriorly and laterally, joined at their bases by a slender portion of the organ.

The vitelline gland lies posterior to the ovary in the semicircular space bounded anteriorly by the latter. It possesses from four to six rather blunt lobes, and has much the same appearance as the ovary in sections and toto mounts of the younger proglottids but soon can be distinguished from the latter by the smaller nuclei as the ovarian nuclei rapidly enlarge toward maturity.

The seminal receptacle is about 0.3 mm long, and lies bent around the anterior and median border of the poral testis, its rounded inner end reaching almost to the ootype. Its duct is short and uncoiled. The lateral portion lies ventral to the seminal vesicle and reaches almost to the longitudinal excretory vessels, always passing dorsal to the latter, as does the sperm duct, and along the posterior side or somewhat ventral to the cirrus sac to the genital cloaca, into which it opens immediately posterior or somewhat ventral to the cirrus sac.

The outer shell of the eggs varies in length from 23 to 30μ, and in width from 17 to 28μ, the average size being 21 by 27μ. The inner shell is closely applied to the embryo, and the middle usually so close to the outer that there is no appreciable distance between them, but may be easily distinguished where the middle is folded inward. The embryo is on the average 12 by 23μ in size, but varies in length from 17 to 25μ, and in width from 10 to 16μ. The six hooks are about 9μ in length and their shape is represented in figure 66.

Here as usual the excretory system of the proglottids consists of two longitudinal vessels in each lateral portion about 0.4 mm from the margin. The ventral vessel is much the larger, being about 120μ in diameter while the dorsal is only about 25μ in diameter. The small dorsal vessel curves laterad and mediad much more sharply than the larger, and may be as far out as the middle of the internal seminal vesicle. The larger, on the other hand, lies along the margin of the testes and passes almost invariably under the small sperm duct joining the seminal vesicle and sperm sac. No trace of transverse excretory vessels has been observed either in totos or sections.

Because of the great similarity between this form and *W. introversa*, the reader is referred to this section in the description of the latter species for a comparison of the organs.

WEINLANDIA INTROVERSA N. SP.

[Figs. 72-77]

The material which formed the basis of the following description was obtained from the intestine of two specimens of *Anas platyrhynchos* Linnaeus, the mallard duck, obtained at Peoria, Illinois, November 23 and

25, 1923, preserved in the author's collection under the numbers 577 and 578, and from one specimen of *Anas rubripes*, the black duck, at Monticello, Illinois, on November 3, 1923, and preserved in the author's collection under the number 498a9. But a single specimen was obtained from the latter host along with several specimens of *W. macrostrobilodes*.

The specimens of this species are much like *W. macrostrobilodes* in position of the testes, ovary, and other internal organs, but they can be distinguished with considerable certainty by their smaller size, being only from about one-third to two-thirds as long. The specimens studied were from 50 to 80 mm in length and about 1.5 to 2 mm broad at the widest part. The anterior portion of the strobila is slender, being less than 1 mm wide in the region about 30 mm behind the scolex, but increases rapidly in width and thickness from there on posteriad, the posterior one-fourth to one-half of the strobila being usually of almost uniform width. When the number of proglottids was counted in comparing the position in the strobila where the testes and ovary had reached about the same stage of development as in *W. macrostrobilodes*, it was found that this point was from 300 to 400 proglottids behind the scolex, while in *W. macrostrobilodes* there were only about 300 in any instance. When the distances were compared, in *W. introversa* it was found to be about 25 mm from the scolex, depending on the state of contraction, while in *W. macrostrobilodes* it was 40 to 60 mm. An accurate idea of the comparative width and size of the internal organs may be obtained by comparing figures 68 and 75 which are camera lucida drawings of the same magnification made of the testes and ovary in relatively the same extent of development in the two species. All of the specimens of the two species have been compared with these drawings.

The scolex shown in figure 73 is about 0.2 mm wide when measured across the extended suckers. The latter are 0.08 mm wide and the rostellum 0.05 mm long by 0.07 mm in maximum width. There are 20 hooks 17 to 20μ in length, which have the shape indicated in figure 74. When the hooks are compared in number, size, and shape with *W. macrostrobilodes*, it is a striking fact that they are almost identical in every way and the one might easily be mistaken for the other, due to the difficulty of observation or to variations. The rostellum is retracted as an introvert. A drawing of a longitudinal section is shown in figure 72, which shows the arrangement of the musculature. There is a bulb-like mass of muscles and connective tissue attached in the central portion of the tip within the crown of hooks. This permits the hooks to be inverted so that their blades are directed outward when the whole is retracted. This is an entirely different arrangement from that found in the scolex of *W. macrostrobilodes* (Fig. 63).

In the male system, which has been referred to above, the internal organs are almost identical in position and general structure with those of *W.*

macrostrobilodes except that they are smaller. The three testes are arranged, one poral and the other two antiporal, one of the latter being in front of and median to the other. They are irregularly lobed by slight indentations about their edges, and have the vasa efferentia arising on their median borders. The vasa efferentia pass medially in each instance, the two from the antiporal testes uniting before joining the duct from the poral testes. No irregularities were observed in these ducts although a number of proglottids were examined. It is not improbable, however, that such occur since they are so common in other species.

The cirrus sac (Fig. 76) contains a large internal seminal vesicle occupying about one-half of its interior when filled with spermatozoa. The cirrus is a narrow structure extending from the outer end of the latter to the opening into the genital cloaca through a mass of cells and muscles. It is somewhat coiled when not extruded. The pore is located on the anterior portion of the margin of the proglottid, and opens into a rather deep narrow genital cloaca with which the cirrus (above) and the vagina (below) communicate. The genital ducts both pass dorsal to the excretory ducts and the pore is always on the right hand side of the proglottid. The external seminal vesicle begins laterally just inside the excretory ducts and reaches to the center of the proglottid. It is an elongated cylindrical sac of about the same diameter when filled with spermatozoa. It is joined to the internal seminal vesicle by a somewhat coiled duct, which in ripe proglottids, becomes expanded in portions into reservoirs for spermatozoa.

In the female reproductive system the organs are also placed similarly to *W. macrostrobilodes*. The ovary is centrally placed between the poral and antiporal testes, and becomes large in ripe proglottids extending about half way across the testes on either side. It is slightly lobed in front, and somewhat curved anteriorly in the center. The vitelline gland is but slightly lobed and lies directly behind the central portion of the ovary.

The vagina is a thin-walled duct which opens into the genital cloaca ventral to the cirrus and usually lies ventral to the cirrus sac and external seminal vesicle. The portion medial to the excretory ducts becomes distended by spermatozoa in ripe proglottids, forming a seminal receptacle anterior to the poral testes and ventral to the external seminal vesicle. The uterus has the course indicated in figure 69 and described for *W. macrostrobilodes*. No mature eggs were observed in any specimens. The musculature does not show any marked differences from that as described for and figured for *W. macrostrobilodes*.

When the literature is examined with reference to the position of the testes, the following species are to be considered: *Weinlandia coronula* Dujardin 1845 has the three testes arranged in a similar manner, but they are much smaller in size, the proglottids are much shorter in proportion to the width of the worm than in the above described form, and the testes

are oval along the transverse axis of the proglottid. The musculature of *W. coronula* is very characteristic, the two longitudinal layers being very sharply differentiated while in both *W. macrostrobilodes* and *W. introversa* there is very little difference in size and location. The hooks are about the same size, shape, and number as in both *W. macrostrobilodes* and *W. introversa*, but in view of the above points one would have little difficulty in distinguishing the one from the other. *Weinlandia querquedula* Fuhrmann 1913 has a somewhat similar arrangement of the testes as both the latter named, but they are evenly rounded, not lobed, and the antiporal and poral are widely separated from each other, the space in between being occupied by the larger ovary, which extends the full length of the proglottid. The hooks are somewhat similar in shape, the anterior basal portion being somewhat less distinct, however, and the size 14μ, and the number 16.

Of the species which are found in Anseriformes, there are none which compare with these in length and number of hooks except those mentioned above. Of those concerning which nothing is known regarding the hooks, *W. lobata* Fuhrmann (1906: 352) has a similar arrangement of testes, but widely separated on the two sides of the proglottid and the space between occupied by the ovary. *H. megalhystera* v. Linstow (1905: 5) has hooks somewhat similar in shape, size, and number, but the testes are arranged in a transverse row.

WEINLANDIA MICROCIRROSA N. SP.

[Figs. 91-97]

The specimens of this species were obtained from the anterior one-fourth of the intestine of *Planesticus migratorius* (Linnaeus), the robin, killed at Urbana, Illinois, April 4, 1923. They were obtained from three hosts and are preserved in the author's collection under the numbers 112b2, 114b4, and 115b2.

The specimens are 30 to 36 mm long in a very much contracted condition. They were found to be most difficult to kill in anything like an extended condition. When allowed to remain in normal salt solution undisturbed, they would relax themselves to two or three times the above length, but when placed in the killing solution, they would immediately contract although attempts to keep them extended by stretching with the fingers or by shaking were made. When held extended in the fingers, they very readily pulled themselves in two in their efforts to contract. The only method tried that was even partially successful was to allow the worm to extend itself on a glass slide, and to quickly place another slide over it binding the two together with rubber bands, in which condition they were placed in the killing fluid. This resulted in specimens that were much contracted and in some instances poor fixation of the internal structures. Specimens killed in this manner were about 2 mm wide at their widest point

and 30 to 36 mm long. In life they are capable of extending to two or three times this length.

The scolex of the specimen from which the drawing was made is 0.1 mm wide, and has the four suckers directed forward in the contracted state. There is no neck region, since strobilization can be made out along the border at the widest portion of the chain opposite the rostellar sac. Behind this point, the strobila rapidly narrows to about one-half the above width and then gradually widens again. In one specimen, the scolex is but little wider than the anterior portion of the strobila. The rostellum is retracted into the rostellar sac in all the specimens studied, and is about 0.2 mm in diameter, evenly rounded and bears a single crown of ten hooks which are shaped like figure 93, and are about 12μ long.

In the male reproductive system the three testes are placed two in the posterior portion, one on either side of the ovary and the other in front of the antiporal posterior testes. The latter may be medial to, directly in front of, or lateral to the posterior antiporal testis. They vary much in size, but in specimens fixed in the partially contracted condition, they are about 200 by 85μ, being longest in the transverse axis of the strobila. Their ducts arise on the median border in each case. Occasionally there are two from a testis, but usually only one, and pass in an almost straight course to their point of union. The manner of union is variable as indicated by the drawings of four consecutive proglottids in figure 1. The vas deferens is short and connects with the external seminal vesicle which lies in front of the ovary in the right half of the proglottid. The external seminal vesicle is connected with the internal seminal vesicle by means of a duct which is gradually tapering laterally. The cirrus sac (Fig. 96) extends somewhat beyond the excretory ducts, and the larger part of its interior is occupied by the internal seminal vesicle. The walls of the vesicle and sac are rather heavy, and wide circular ridges along their sides are seen in cross section. These are more prominent in the outer half than the inner. The cirrus is short, straight, and spineless, and opens just dorsal to the vagina into the shallow genital cloaca. The pore is situated about one-fourth of the way back on the right hand margin of the proglottid.

In the female reproductive system the ovary is a deeply lobed transversely elongated organ located in the center of the proglottid. The vitelline gland lies just behind it and the vagina comes in from the right and anteriorly at about the middle of the proglottid. The seminal receptacle lies ventral to the external seminal vesicle, its inner end sometimes bending posteriorly around the poral testes. It communicates with the genital cloaca through a long, slender, straight vagina which lies directly ventral to the cirrus sac and opens almost directly ventral to the cirrus.

The eggs in the uterus have three shells with the six-hooked embryos within. The two outer shells are very thin and often much distorted by

shrinkage. The average length of the outer is 45μ and width 40μ, with a maximum of 54 by 45μ, and a minimum of 42 by 31μ. The middle shell averages 40μ in length and 31μ in width with a maximum length of 42μ and a width of 39μ, and a minimum length and width of 33μ and 23μ. The embryo averages 38 by 25μ and has a maximum of 35 by 38μ, and a minimum length and width of 31 by 21μ. The hooks are 17 to 20μ long.

The longitudinal muscle layers are well developed, especially the outer one. The inner contains a much less number of bundles. The oblique muscles are very poorly developed, and in most proglottids none were found except in the outer angles. The regions separating the proglottids are clearly defined.

The large ducts of the excretory system are about 0.15 mm in diameter and the small dorsal duct about 0.05 mm in diameter, 1 cm from the scolex. No transverse vessels joining either of the longitudinal vessels could be traced.

The longitudinal nerve lies about 0.15 mm from the margin of the proglottid and under a point about one-fourth the length of the cirrus sac from its outer end.

When the descriptions of the various species are compared with the above description with reference to the position of the testes, the following deserve mention: *Weinlandia lobata* Fuhrmann (1906: 352) has the testes arranged in a similar position, and the cirrus sac is much like the one described above, but the onchosphere is 16μ in diameter, while in our species it averages 25 by 38μ. The scolex was absent from Fuhrmann's specimens but the length of the strobila is 14 cm, while the above described specimens were not over 8 cm long when fully extended, and but about 35 mm when fixed. *H. minor* (Krabbe) 1869 has hooks similar in shape and length but 14 in number. It is 25 mm long, and was found in *Phalaropus hyperboreus* (Linn.) a bird belonging to the Charadriiformes, while the robin belongs to the *Passeriformes*. *H. minor* is so poorly described that it ought to be disregarded as a species unless the original material can be restudied.

When compared with the species of Hymenolepis that have been recorded from the Passeriformes, there are only three which have similar hooks. *H. bilharzii* Krabbe 1869 has hooks that are much more strongly constructed in all parts and 16μ long. It is so poorly described that it must probably be disregarded. *H. palygramma* (von Linstow) 1875 has hooks 17μ long and was described from immature material having no sex organs. *Weinlandia importata* Fuhrmann 1918 has hooks 12 to 16μ long, but they are very slender and have a very long anterior basal portion and almost no posterior basal portion. There seems little doubt, therefore, that the above described species is new.

WEINLANDIA PLANESTICI N. SP.

[Figs. 98-103]

The cestodes used in the study of this species were obtained from 9 specimens of *Planesticus migratorius*, robin, killed at Urbana, Illinois, between April 1 and May 1, 1923. They were taken from the middle three-fourths of the intestine and were found either attached to or free from the intestinal wall. The specimens are preserved in the author's collection under the numbers, 104, 105, 106, 108, 113, 114b, 123b, 125, 174b. Of this species cotypes were placed in the Ward Helminthological Collection at the University of Illinois, Urbana, nine mounts, comprising five totos and four sets of serial sections.

The specimens vary in length from 10 mm to 35 mm, and in width from 0.5 to 1.5 mm, depending on the stage of contraction and maturity of the worm. One specimen with mature eggs measured 20 mm long and 1 mm wide near the posterior end.

The scolex in all the specimens was strongly contracted and was about 0.2 mm broad, depending on the size of the worm. The suckers are strongly contracted, and are not raised appreciably above the surface of the scolex, the opening being directed forward. The rostellum is a strong muscular structure which is retracted into the rostellar sac as a solid muscular organ, and not as an introvert, the blades of the hooks always being directed backward. The rostellum carries a crown of ten hooks which have the shape represented in figure 101 and a length of about 14μ. Strobilization is evident immediately behind the scolex.

In the male reproductive system two of the three testes are placed on the posterior side of the proglottid, one poral and the other antiporal, and the third in front of the antiporal one. The latter is usually directly in front of the posterior testes, but in some specimens especially, its position varies, being placed either somewhat medially or laterally. The vasa efferentia are very variable in this form, as is indicated by the various figures. The number arising from each testes varies from 1 to 3, any testes may have any number up to three. Neither do the ducts pass directly to their point of union but may curve about and be joined by short ducts with each other giving the appearance of a network. Invariably, however, the ducts from the two posterior testes join before meeting those from the anterior testes. The testes are 0.06 to 0.08 mm in diameter in the region where the ovary and other female organs are well developed.

The vas deferens is a comparatively short duct. The external seminal vesicle communicates with the internal seminal vesicle through a short, usually somewhat coiled, duct.The internal vesicle is a simple sac, its inner portion being considerably larger than the outer and occupying about three-fourths the length of the cirrus sac. The cirrus is a slender tube and

is but slightly coiled, opening into the genital atrium dorsal to the opening of the vagina. Both the vagina and cirrus sac pass dorsal to the excretory vessels and the nerve, the large end of the cirrus sac lying directly above them. The pore is to be found slightly in front of the center of the proglottid, exactly on the margin, and on the right hand side.

In the female system the ovary lies in front of the two posterior testes and somewhat ventral to them. It is an elongate structure with irregular fan-shaped lobes on the anterior border. The vitelline gland lies behind it and is a rounded or oval organ without lobes. The seminal receptacle lies ventral to or somewhat posterior to the external seminal vesicle, and is very variable in shape, but generally elongated or oval in outline. The vagina is a long, wide, straight duct extending from the outer end of the seminal vesicle to its opening ventral to the opening of the cirrus in the genital atrium.

The eggs are very irregular in shape, due to shrinkage of the outer shells. The shells are very thin and the two outer have the space between them filled with material which is probably a loose cellular mass in the process of disintegration, while the space between the middle and inner shells is clear. The average size of the outer shell is 47 by 35μ, with a maximum length of 56μ, and a maximum width of 42μ. It has a minimum length of 42μ and a minimum width of 28μ. The average length of the inner shell is 38μ and the average width 27μ, its maximum length and width being 44 and 33μ respectively and its minimum 33 and 23μ. The embryo has an average size of 32 by 24μ, a maximum length and width of 40 and 30μ, and a minimum length and width of 28 and 19μ.

The inner longitudinal muscle layer contains about 25 bundles on each side of the proglottid, while the outer layer contains about 50 bundles.

The dorsal excretory vessel is somewhat smaller than the ventral, being about 18μ in diameter, while the other is about 23 to 25μ in diameter. Transverse vessels joining the longitudinal vessels have not been found.

A comparison of the above species with others necessitates a discussion of the following: *W. farciminosa* (Goeze) 1782, has hooks similar in shape, but 20 to 23μ long, while in the above they are 14μ long. Rosseter's (1908: 295) discussion of this species shows that the material which has been referred to it is in need of restudy since but little attention has been given the internal organs by most of the investigators, and Rosseter gives figures of the hooks from four sources which vary in shape. It is not possible to determine whether the material which Rosseter examined was identical with that of all the others or not on account of the incompleteness of the other descriptions. Fuhrmann (1908, footnote 4, p. 79) gives a discussion of its synonomy.

Of the species which have been described from Passeriformes whose size of hooks are near that of the above described form, the following should

be mentioned: *H. petrocinclae* Krabbe 1882 has hooks 18μ long, but very different in shape; *H. polygramma* (von Linstow) 1875, length 17μ, but the two lateral testes are lateral to the longitudinal excretory vessels according to Fuhrmann (1906: 734). *H. bilharzii* (Krabbe) 1869 has the blade shorter than the base, and the anterior portion of the base shorter than in the above described form; *Weinlandia serpentula* (Schrank) 1788, has hooks 24 to 27μ long, almost twice as long as in the form under discussion and a much longer and heavier anterior basal portion. Ransom (1909: 96) records this form from *Planesticus migratorus* with a question mark, but the reference which formed the basis for this statement is not given and has not been located during the present study. Fuhrmann 1908 does not include the name of the host in his list of cestodes under their hosts. It seems clear, then, that the form just described should be designated as a new species.

GENUS WARDIUM NOV. GEN.

Diagnosis: Three testes in a proglottid. Position of the testes in the different proglottids of the strobila variable. Scolex armed with a single crown of hooks. Genital pores unilateral. Uterus sac-like. Genital ducts dorsal to the excretory canals.

Type species: *Wardium fryei* n. sp.

WARDIUM CAPRIMULGORUM (FUHRMANN) 1906

Fuhrmann 1906c: 441 (Figs. 16-19); 1906e: 740.
Syn.: *Drepanidotaenia caprimulgorum* Fuhrmann 1906c,
Hymenolepis caprimulgorum Fuhrmann 1906e.
Hosts: *Nyctiprogne rupestris* (Spix), *Podager nacunda* Cab.
Caprimulgus lineatus.
Locality: South America.

Through the courtesy of Dr. Anton Collin, Director of the Zoologisches Museum der Universität, Berlin, Professor Ward received alcoholic material representing this species which was sent on loan and proved very valuable. For this courtesy the author desires to acknowledge here his indebtedness to the Museum and its Director.

Length 12 cm, width 1.5 mm. Testes variable in position. Cirrus sac small, not reaching the longitudinal excretory ducts. An internal and an external seminal vesicle present. Fuhrmann did not have any scolices when he first described the species, but he afterward found some and gives their description in 1906e: 740. They are 0.14 mm in diameter, and the rostellum is armed with 10 hooks which are 14μ in length.

WARDIUM CAPILLAROIDES (FUHRMANN) 1906

Synonym: *Hymenolepis capillaroides* Fuhrmann 1906.
Fuhrmann 1906b: 355.
Hosts: *Podiceps dominicus* (L.).
Locality: Brazil.

Alcoholic material representing this species was sent from the Zoologisches Museum der Universität, Berlin, through the Director, Dr. Anton Collin, to the Ward Helminthological Collection at the University of Illinois, Urbana, and was placed at the disposal of the author who is greatly indebted for these courtesies.

Length 3 cm, width 0.4 mm. Scolex 0.1 mm in diameter. Hooks are 10 in number and 21μ long. Cirrus sac reaches beyond the longitudinal

excretory vessels but not beyond the center of the proglottid. The testes are arranged so that all three may lie in a transverse row or the antiporal testes somewhat anterior to or in front of the median testis. Ovary and vitelline gland median and small in size. Uterus sac-like and fills the entire interior of the proglottid.

Southwell (1916: 10) found several specimens of a cestode in *Corvus macrorhynchos*, a crow, at Calcutta, which he thinks possibly are *Wardium capillaroides*. This material should be restudied since the testes were observed to be regular in position, the posterior proglottids were square, and the details concerning the hooks could not be determined with certainty. The wide difference in the hosts is further indicative of different species.

WARDIUM AMBIGUUM (CLERC) 1906

Synonym: *Hymenolepis ambiguus* Clerc 1906.
Clerc 1906a: 535.
Host: *Otis tetrax*.

Length 120 mm, maximum width 0.7 mm. Scolex 0.22 mm in diameter. Hooks 10 in number 30μ in length. Genital pores unilateral, and the genital ducts pass above the excretory vessels. Cirrus sac 0.18 mm long. External and internal seminal vesicle present. The only statement relating to the position of the testes is that they are variable according to the state of contraction of the strobila. There is, therefore, some uncertainty as to the exact genus to which this species should be placed. It should be restudied in order to determine its exact relationships.

WARDIUM VARIABILE N. SP.

[Fig. 17-23]

Two specimens of this species were taken from the intestine of a specimen of *Corvus brachyrhynchos*, the common crow, killed at Monticello, Illinois, on November 10, 1923, and are preserved in the author's collection under the numbers 530.1 and 530.2. The length of one is 30 mm and its greatest width is about 1 mm near the posterior end. The other specimen is 20 mm long and 0.7 mm wide at its widest point. They each contain about 250 proglottids, of which the anterior 100 or so are very short in proportion to their width. Behind this point the reproductive organs rapidly develop, the testes first and the female farther back.

The scolex is conspicuous, being much wider than the anterior end of the strobila. It is about 0.2 mm wide or slightly less, while the width of the neck region is 0.06 mm. The suckers are 0.08 mm in diameter, and somewhat raised above the surface of the scolex. The rostellum was retracted in both specimens, in which condition it is a rounded organ about

0.02 mm in diameter. It is armed with a single crown of hooks which measure from 20 to 22μ in length. The base is much curved and for this reason the shape of the hook may be easily misjudged unless one is careful to observe one which lies with all its parts as nearly as possible in the same plane of focus.

The testes are regularly three in number, although four proglottids were found out of 102 which had four each and one had but two. Their arrangement in 67 of the 102 cases was two on the posterior border and one antiporal and lateral to the posterior antiporal testes. Four had the anterior antiporal testis in front and one medial to the posterior antiporal testis, while eleven proglottids had the three organs in a row on the posterior border. In nine instances the two lateral testes were both anterior to the median which was on the posterior border of the proglottid; in five proglottids two were poral, one testis being anterior and lateral to the posterior, and but one instance was found where two only were observed, they being on the antiporal side.

The cirrus sac extends medially about one-third the width of the proglottid and in each instance observed contained a relatively small internal seminal vesicle. However, the latter was not observed distended with spermatozoa. It is thick walled and has a layer of small nuclei about its outer margin. The cirrus extends from the outer end of the internal seminal vesicle outward and extends through about two-thirds of the length of the sac. It opens into the genital cloaca dorsal or anterior to the vagina. The genital cloaca is a wide rounded cavity up into which an elevation of the surrounding tissue of the proglottid extends. The pore is to be found about one-fourth the way back on the right hand margin of the proglottid. The external seminal vesicle lies directly in front of the vitelline gland and ovary, the latter extending beneath it when reaching maturity.

The ovary lies in the anterior ventral portion of the proglottid, beneath the external seminal vesicle and the vagina. It is divided by deep constrictions on the anterior side into several lobes up to about six in number which extend anteriorly and laterally in a fingerlike manner. The whole organ is somewhat bent anteriorly in the center, and has the vitelline gland and shell gland placed in the posterior concavity. When fully developed, it extends somewhat farther laterally than shown in figure 22a, but never reaches to the excretory vessels. The vagina lies beneath or slightly posterior to the cirrus sac and is a rather thick-walled duct which widens out at its inner end to form a seminal receptacle dorsal to and behind the ovary. The vitelline gland is a spherical or oval organ lying just behind the ovary. Between the ovary and vitelline gland or slightly more ventral, the shell gland is to be found. The uterus is a transverse sac which is irregularly divided by partial septa into several lobes. The eggs were present in large numbers, but in neither of the specimens obtained were they

mature. A few large single cells were observed which apparently were unfertilized eggs and consequently had not developed.

The ventral longitudinal ducts are considerably larger than the dorsal, as is usual in this group of cestodes, being about 35 by 25μ in diameter, while the dorsal are 14μ in diameter. The large ventral vessels are connected by transverse vessels 7μ or wider in diameter, while no such connections occur between the dorsal vessels. Occasionally these transverse vessels are branched at the end (Fig. 23). The longitudinal nerve lies on each side usually about half way between the excretory vessels and the border of the proglottids. The longitudinal muscles are differentiated into two well defined and widely separated layers (Fig. 17). The inner one contains about a dozen bundles on a side. The outer contains about 20 to 25 bundles which are about 5μ in diameter while the inner are about 12μ in diameter.

A discussion of this species with reference to the literature is indeed difficult when considered with reference to the position of the testes. One of the most satisfactory descriptions of a species with testes variable in position is that of *W. caprimulgorum* Fuhrmann (1906c: 441), collected in Brazil from *Nactiprogne rupestris*, *Podager nacunda* and *Caprimulgus lineatus*. The most outstanding differences are, however, the very small cirrus in *W. caprimulgorum*, where it reaches only about half way to the excretory vessels on the poral side, and the hooks which are 14μ long, while in the above described form they are about one-third longer, the anterior portion of the base being much shorter than in that described above. The difference in the orders of birds to which the hosts belong is also marked, that of *W. caprimulgorum* being Coraciiformes while the crow to the Passeriformes. Another species which is recorded as having testes variable in position is that of *W. capillaroides* Fuhrmann 1906, but in this the testes are smaller and the two on the antiporal side are some distance removed from the poral testes, the pore is in the center of the proglottid, while in the above described form it is only one-third the way back on the border. The hooks, although of about the same size, are more slender in structure throughout while the host of *W. capillaroides* is a grebe.

When the literature is examined with reference to the species that have been recorded from the Passeriformes, it is found that there are, in all, 24 species. When the size of the hooks from these various species are compared, it is found that only those species included in the following comparative table agree near enough in size to be considered. In the following table some of the important characters are compared with the species described above.

From the following table one sees that the hooks of *W. variabile* differ in shape from those of the other species infecting Passeriformes which have hooks of a similar length. Four of the species have the location of the testes very inadequately described and no statement is made as to the

TABLE I

Comparison of Somewhat Similar Species

	Position of testes	Shape of hooks	Size of hooks
Wardium variabile	67% Variable	Blade and 2 parts of base about equal	20 to 22 μ
H. hemignathi	Transverse row	Blade very long	18 to 23 μ
H. petrocinclae	?	Anterior portion base very long	18 μ
W. passerina	2 antiporal 1 before the other	Ant. portion base very long, blade and post. portion base very short	20 μ
W. interruptum	2 antiporal 1 before the other	Ant. portion of base much longer than post and blade	20 μ
W. microscolecina	2 antiporal 1 in front of other	Blade and 2 parts of base about equal but ant. portion of base much heavier than in above described form	23 μ
W. farciminosum	Straight line?	Both parts of base much heavier than in above described form	21 μ
W. serpentulum	2 poral, 1 before other, separated from other posterior	Post. part of base very heavy	25 to 27 μ
W. globocephalum	2 antiporal, 1 in front of other, but small and separated far from poral testes	Very heavy in structure in all parts	19 μ

variability of their position in any of the descriptions. No records are given by Fuhrmann (1908) of any cestodes from any of the species of crow in North America. It seems quite clear then that this species is new.

WARDIUM FRYEI N. SP.

[Figs. 24-31]

The material from which this description was written was obtained from the intestine of a specimen of *Larus glaucences*, the glaucous-winged gull, killed in San Juan county, Washington, July 20, 1923, and is preserved in the collection of the writer under the number 276.

The specimens are very slender cestodes which measure 115 mm in maximum length but do not exceed 1 mm in width at their widest point. The anterior 25 to 30 mm is very slender, and disintegrates very early after the death of the host. The male sex organs are well developed in

proglottids 20 to 30 mm from the scolex, and the beginning of the female organs is well differentiated. It should be noticed especially at this point that the start of the ovary in the early stages and the fully formed organ may be very easily confused with the testes and therefore it is only possible to identify these organs with certainty from sections. Frontal sections are the most useful as the ovary is ventral and is not obtained to any great extent in sections containing the testes. Because of the great variability of the position of the testes, these organs cannot be identified by their location as they can in species characterized by regularity of position. Proglottids about 50 mm from the scolex are about 0.35 mm in transverse diameter by 0.2 mm in thickness, while at the extreme posterior end they are usually less than 0.8 mm wide. The pore is unilateral and on the right hand side of the proglottid.

The scolex is somewhat larger than the strobila immediately behind, it being about 106μ while the strobila is about 70μ in width. The rostellum is short, rounded, and armed with a single crown of ten hooks. But three scolices were obtained, from two of which the hooks had been lost. The other had ten hooks, 17 to 19μ long, shaped like figure 26. The rostellum was not retracted, although there was a deep rostellar sac extending as far back into the scolex as the posterior border of the suckers. In so far as it could be made out, the rostellum seemed to be retracted as a solid organ and not as an introvert.

The three testes are placed in an irregular manner, the proglottids in which they are placed in an almost transverse row are somewhat more numerous than are those with the other arrangements. They may, however, be placed so that two are on the posterior side and the other directly in front or somewhat lateral to either the poral or antiporal testis, or one may be median and posterior and the others one on either side and somewhat anterior to it. Of 169 proglottids examined, of which about an equal number were counted for each of four specimens, the testes were distributed as follows: 45 had all three in a row; 55, one was posterior and one on each side and anterior to it; 50, two posterior and the other anterior or lateral to antiporal testes, and 19 in which two were posterior and the other anterior or lateral to the poral testes. The testes are crowded ventrally or dorsally, or indented by the cirrus sac and external seminal vesicle, depending upon the stage of development of the organs, the ripe proglottids being very well filled in the central portion by reproductive organs.

The cirrus sac is very large and occupies the anterior half of the poral side of the proglottid, opening into the genital cloaca which lies on the right hand side of the proglottid a little in front of the center of the border of the proglottid. It appears very early and soon comes to contain the very large cavity of the internal seminal vesicle, which occupies the larger part of the interior, and almost fills it when filled with spermatozoa. The cirrus

is a thick fleshy organ, the duct of which is thin walled and much coiled in the unextruded organ. It opens into the internal seminal vesicle at the outer end of the latter. What appears to be the cirrus when extruded is seen to contain numerous small nuclei and to be made up of loose connected tissue, the outer surface being entirely free from hooks or spines (Fig. 10). The external seminal vesicle is a large thin-walled sac which lies just medial to the inner end of the cirrus sac and communicates with it through a short, wide, somewhat coiled duct. The external seminal vesicle and cirrus sac together reach a little more than half way across the proglottid in most cases.

The ovary (Fig. 28) is an irregularly lobed organ lying posteriorly in the proglottid and ventral to the testes, the anterior portion of the proglottid being occupied by the cirrus sac and external seminal vesicle. The vagina lies directly ventral to the cirrus sac and opens into the genital cloaca ventral to the cirrus (Fig. 22). It is a clearly defined, heavy-walled duct somewhat coiled and widens out forming the seminal receptacle which lies just ventral to the inner end of the cirrus sac. The vitelline gland is irregularly rounded or oblong, and lies dorsal and anterior to the ovary and ventral to the testes and cirrus sac.

The uterus is a transverse sac divided incompletely into compartments by septa and well filled with eggs in the mature proglottids. The embryos are oval in shape and average 34 by 28μ in size but range from 28 to 40μ long by 23 to 40μ wide. Figure 25 represents about an average shape but they are often more elongate or more rounded. The outer shell ranges in diameter from 37 to 52μ by 26 to 49μ and averages 26 by 37μ. The inner shell is closely applied to the embryo, but two shells could be made out on any of the eggs. Although the hooks are well developed and apparently fully formed, no trace of the middle shell could be found. Ransom found a somewhat similar condition in the eggs of *Hymenolepis cantaniana*, differing however, in that the contents of the egg of the latter is separated into two regions separated by a very thin membrane. The hooks are often found extending through the outer shell, and are very prominent, having a characteristic enlargement on the shaft about three-fourths the distance from the inner end. This enlargement in many appears to go entirely around the shaft while in others this is not apparent. The hooks are from 14 to 17.5μ in length, and great care must be used in selecting those to be measured in order to have the entire hook as nearly in the same plane of focus as possible.

It is difficult to make a comparative study from the literature of the forms known to show variability in the position of the testes. Earlier workers apparently failed to appreciate the possible importance of recording such variations in an exact manner. Fuhrmann seems to be almost the only investigator who has taken any notice of this fact, and has described two

species as having this peculiarity. These are *W. caprimulgorum* Fuhrmann 1906 and *W. capillaroides*. Aside from the great difference in the hosts, the hooks are very different in shape, in that they both have well-developed anterior basal portions, while the above described species has none at all. *W. ambiguum* Clerc 1906 has testes somewhat variable in position but the hooks are almost twice as long, and it has a long anterior basal portion. *H. clandestina* (Krabbe) 1869 is the fourth species to which reference has been made to the testes being in a variable position, but here again the hooks have a long anterior basal portion and are twice as long as in the case of the above described form.

Five species of Hymenolepis have been recorded from the Lariformes. All five of them have hooks very different in shape, or of a different number, from those in the species first described, as well as other characters. It seems proper to conclude that the above described species should be designated as new.

GENUS ECHINORHYNCHOTAENIA FUHRMANN 1909

Generic diagnosis: Genital pores unilateral. Genital ducts pass between the longitudinal excretory vessels. Testes three in number. Uterus sac-like. Rostellum proboscis-like and covered with hooks.

Type species: *Echinorhynchotaenia tritesticulata* Fuhrmann 1909.

This genus was erected by Fuhrmann to accommodate *E. tritesticulata* and placed in the family Dilepinidae. The number of the testes in the two species thus far assigned to it, however, is believed to justify its transfer to the family Hymenolepididae. The internal anatomy is indeed similar to that found in the genera Wardium and Hymenolepis, but in view of the constancy of the position of the genital ducts with reference to the excretory ducts in the species studied and the probable systematic importance of this character, the retention of the genus Echinorhynchotaenia seems justified at the present time. Although the structure of the proboscis has not been studied, it is probably not much different from an introvert. The main difference between the introvert and the rostellum retracted as a solid body is in the degree of muscular development and arrangement, and serves as an important specific character but is not of generic value. The arrangement of the hooks is, likewise, of less importance than the internal structures of the proglottids.

ECHINORHYNCOTAENIA TRITESTICULATA FUHRMANN 1909

See Fuhrmann 1909:32-35, (Figs. 28-31)
Host: *Anhinga rufa* (Lacep. Dand)
Locality: Africa

Length 30 cm, width 4 to 5 mm. Testes variable in position and 3 in number. Genital pores unilateral. Genital ducts pass between the longitudinal excretory vessels. Ovary divided into two portions, each deeply lobed. Uterus sac-like and lobed.

ECHINORHYNCHOTAENIA NANA MAPLESTONE AND SOUTHWELL 1922

See Maplestone and Southwell 1922:193-197, (Figs. 5-7)
Host: *Chenopsis atrata*, Lath., the black swan.
Locality: Townsville, North Queensland.

Length 2 cm, width 1.7 mm. Scolex 1.5 mm wide and 2.3 mm long. Behind each sucker is a lappet. Segments broader than long. Genital pores unilateral, and open on the right hand side of the proglottid. Longi-

tudinal muscles in two layers. Unfortunately the proboscis had apparently been torn out, but the "appearance of the head, with a few ragged fibers protruding from the central pit, leaves no room for doubt that a proboscis has been present." The material was in a bad state of preservation and could not be completely described in other respects. The relation of the genital ducts to the excretory vessels was not stated. This species should be more completely studied from material in a better state of preservation with the view of determining more accurately its relationships.

GENUS HYMENOFIMBRIA SKRJABIN 1914

Generic diagnosis: Three testis in a proglottid. Scolex with a single crown of hooks. Genital pores unilateral. Excretory system consisting of ten longitudinal vessels. Uterus a simple sac. Longitudinal musculature consists of a single layer. Strobila well marked off into proglottids. Pseudoscolex absent.

Type species: *Hymenofimbria merganseri* Skrjabin 1914.

HYMENOFIMBRIA MERGANSERI SKRJABIN 1914

See Skrjabin 1914:473-476.
Host: *Mergus merganser*
Locality: Russian Turkestan

The exact length of the parasites could not be given since the type material consisted of fragments, but they were estimated as being about 120 to 150 mm. The maximum width has 4 mm. The scolex is 0.14 mm long by 0.17 mm wide. The rostellum is armed with 10 hooks which are 18μ long and are shaped like *Haploparaxis filum*. The neck is 0.148 mm wide and 0.3 mm long.

The musculature consists of a transverse layer and a single row of longitudinal bundles. The longitudinal bundles measure 34 to 41μ, and each consists of from 40 to 50 fibers. There is also a diagonal muscular layer outside of the longitudinal. The excretory system consists of ten parallel longitudinal vessels. The lateral vessels are asymmetrically placed, two lying outside the longitudinal nerve on one side while on the opposite they are median to the nerve. The three testes lie in a transverse row, one being poral and the other two antiporal to the female reproductive glands. The female reproductive glands are median, and are relatively small. The ovary is somewhat indented on the anterior margin, while the vitelline gland is median and directly behind the ovary. The uterus is sac-like and extends the entire width of the proglottid.

GENUS FIMBRIARIA FROELICH 1802

Scolex small and usually lost, with rostellum armed with a single row of hooks. Strobila without true segments, but with transverse grooves

giving the appearance of segments. Pseudoscolex retains the true segmentation. Excretory system consists of several pairs (three and eleven in the two known species) of longitudinal excretory vessels. Genital pores marginal, unilateral, and on the right hand border of the strobila. Testes three in number for each cirrus pouch. Ovary, reticular or forming network extending through the strobila, or a single simple ovary for each set of reproductive organs. Uterus reticular for the species known.

Type species *Fimbriaria fasciolaris* (Pallas 1781).

FIMBRIARIA FASCIOLARIS (PALLAS) 1781

Synonyms, *Taenia fasciolaris* Pallas 1781; *T. malleus* Goeze 1882; *Fimbriaria malleus* Fröhlich 1802; *Fimbriaria mitra* Frölich 1802; *Alyselminthus malleus* (Goeze 1782) Zeder 1800; *Halysis malleus* (Goeze 1782) Zeder 1803; *T. trilineata* Batsch 1786; *Taenia pediformis* Krefft 1871; *Epision plicatus* Linton 1892; *Fimbriaria plana* von Linstow 1905; *Notobothrium arcticum* von Linstow 1905.

This species has been very much misunderstood and hence has resulted the long list of synonyms recorded above. Its anatomy is very well described by Wolffhügel 1900, but the true nature of the pseudoscolex, and the arrangement of the reproductive organs were not fully described. These points have been very clearly elucidated by Fuhrmann, 1914, who arrived at the conclusion that the pseudoscolex, instead of being an abnormal portion of the strobila is the most normal, and that there were three testes for each cirrus sac which are arranged in a linear series. For a description of this species, the reader should refer to Wolffhügel 1900, and to Fuhrmann 1914.

FIMBRIARIA INTERMEDIA FUHRMANN 1914

This species is well described by Fuhrmann (1914: 446) and was obtained from the digestive tract of *Somateria mollissima*. For a detailed description the reader is referred to his account.

SUBFAMILY DIORCHINAE

Subfamily diagnosis: Hymenolepididae with regularly two testes in each proglottid.

Type genus: Diorchis Clerc 1903.

GENUS DIORCHIS CLERC 1903

Two testes in a proglottid. Rostellum armed with a single crown of ten hooks in all the described species. Suckers unarmed or armed with minute spines. Inner longitudinal muscle layer consisting of eight bundles, four dorsal and four ventral. Genital pores unilateral. Uterus sac-like. In birds.

Type species: *Diorchis acuminata* (Clerc 1902) Clerc 1903.

DIORCHIS ACUMINATA (CLERC) 1902

See Clerc 1903:281-284, (Figs. 25, 78, 88); Ransom 1909:42-48, (Figs. 30-36).

Hosts: *Nettion crecca, Mareca penelope, Chaulelasmus streperus, Fulica atra, Fulica americana.*

Locality: Europe and North America.

This species is well described by Ransom and Clerc, and the following description is based upon the details given in their accounts. The hooks are ten in number and 38μ in length. The length is 35 mm and the width 0.65 mm. The full-grown worm is probably somewhat longer, as the final segments were not gravid in Ransom's material. The longitudinal muscles are typical of the genus and consist of two layers, the outer composed of numerous small, and the inner of eight large bundles. The excretory vessels lie so that the dorsal is directly above the ventral, and are not connected by transverse vessels. The cirrus sac and vagina pass dorsal to the excretory vessels and nerve. The two testes are located near the dorsal surface in the posterior portion of the segment, one on either side of the median line, and reach a maximum size of 100 to 130μ. An internal and an external seminal vesicle is present. Cirrus sac is elongated, extending transversely across the proglottid, its inner end not reaching the median line. The cirrus is unarmed and has a globular swelling at its base. The vagina forms a seminal vesicle median to the excretory ducts and reaches the inner end of the cirrus sac. The ovary is trilobed, one lobe being anterior and median and the others lateral, often by a division of the left lateral it becomes four-lobed. When fully developed, it extends laterally as far as the excretory canals and the median lobe extends forward to the anterior border of the segment. The yolk gland is spherical, 45 to 60μ in diameter,

located in the median line and behind the middle of the ovary. The uterus is sac-like, developing large lobes which penetrate between the longitudinal muscles and beyond the longitudinal excretory vessels. The eggs are elongate. Jacobi (1898) described the anatomy of *Taenia inflata* Rudolphi, a species very similar to *D. acuminata*, but Ransom thinks this should be regarded as a separate form.

DIORCHIS AMERICANA RANSOM 1909

See Ransom 1909:48-51
Host: *Fulica americana*
Locality: Nebraska, United States.

The length of specimens of this specimens in which eggs were not yet fully mature was 20 to 25 mm and the maximum width 0.6 mm. Rostellum armed with ten hooks 65μ long. Suckers covered with minute spines. The genital pores are unilateral on the right-hand margin of the strobila at about the middle of the proglottid. Nervous system and musculature similar to those in *D. acuminata*. Vagina and cirrus pouch dorsal to the nerve and excretory vessels.

The testes, two in number, of a maximum size of 100 to 130μ, are located in the posterior portion of the segment, dorsal and one on either side of the median line. The cirrus sac extends beyond the median line. Internal and external seminal vesicles are present. The cirrus is very slender and without bulbous enlargement at the base.

The vagina forms an elongated seminal receptacle median to the excretory ducts which extends as far medially as the cirrus sac. The ovary is trilobed with occasionally a fourth lobe on the left hand side. Yolk gland similar in shape and location to these organs in *D. acuminata*. The uterus is a simple sac, and, when fully developed, extends from the posterior to the anterior border of the segment and laterally beyond and dorsal to the excretory canals on the right and ventral to the excretory canals on the left side of the proglottids. Eggs containing fully developed oncospheres were not present in the type material.

DIORCHIS FLAVESCENS (KREFFT) 1871

See Krefft 1871:15 and Johnston 1912:15
Hosts: *Anas superciliosa*, *Spatula rhynchotis*, *Nettion castaneum* and *Aythya australis*.
Locality: Australia.

This species was originally described by Krefft under the name of *Taenia flavescens*. His description was very insufficient, but fortunately, the type material was reëxamined and a very satisfactory description given by Johnston (1912).

The specimens were from 3 to 5 cm in length in most cases but some were as long as 8.4 cm. The suckers are armed with minute spines. Ros-

tellum armed with ten hooks 68μ long, arranged in a single circle. Longitudinal musculature arranged in two series, an outer of numerous small and an inner of eight large bundles. Genital ducts pass dorsal to the excretory vessels. Genital pores are unilateral on the right hand side of proglottid. The two testes are medially placed and attain a size of 0.1 mm. Cirrus sac reaches the middle line and sometimes much farther. An internal and an external seminal vesicle present. Ovary compact, trilobed, and medially placed on the ventral side of the proglottid. When mature the ovary reaches from the excretory vessels of one side to those of the other, one lobe being median and anterior while the others are lateral. The yolk gland is rounded or kidney-shaped and more dorsal in position than the ovary. Vagina forms a seminal receptacle. The uterus extends beyond the excretory ducts, lying dorsal to them on the poral side, but ventral on the antiporal side of the proglottid. Mature eggs are from 90 to 107μ in length and from 27 to 31μ in width. Each end is somewhat bluntly pointed, while each extremity of the inner shell is produced into a very prominent process. The inner shell measures from 54 to 68μ in length by about 16μ in breadth.

DIORCHIS INFLATA (RUDOLPHI) 1809

See Krabbe 1869:285-286, (Figs. 109-11) (*Taenia inflata*). Jacobi 1898:95-104, (pl. 6, 16 fig.) (*T. inflata*); Cohn 1901 :330-331, *Hymenolepis inflata*; Clerc 1903:284-288, (Fig. 89); von Linstow 1906:15-17, (Figs. 17-18), (*H. inflata*)

Host: *Fulica atra* (L.)

Locality: Europe.

The length of this cestode is 80 to 100 mm and its width is 2 to 3 mm. The ten hooks are 23μ long, according to Jacobi. The testes are large and centrally located in the proglottid, the two reaching to the excretory vessels on either side. The ovary and vitelline gland are centrally located. The cirrus sac does not reach the center of the proglottid. The above data are from Jacobi, and since the species has not been reported in the western hemisphere, further details are not included in this report.

DIORCHIS PARVICEPS (VON LINSTOW) 1872

See von Linstow 1872-57 (Figs. 11-12); 1904:306-307 (Figs. 23-25)

Host: *Mergus serrator*.

Locality: Europe.

The length of the specimens of this species is recorded as being 110 mm, and 2.16 mm in maximum width. The pores are unilateral and marginal. The rostellum has ten small hooks 12μ long. The two testes are oval, 130 by 79μ in size. Ovary consists of a number of parts arranged rosette-like in the center of the proglottid. The vitelline gland is located in the center of the ovarian group.

DIORCHIS EXCENTRICUS N. SP.

A number of specimens of a small species of Diorchis were taken from the posterior half of the intestine of *Erismatura jamaicensis*, the ruddy duck, killed at Peoria, Illinois, November 23, 1923. They are preserved in the author's collection under the number 576b.

The length of these worms varies from 26 mm to 52 mm. Even the longest specimen contained no mature eggs, and the uterus was not yet developed in any of the posterior proglottids. The width of proglottids about 30 mm behind the scolex is about 0.7 mm and in the longest a maximum width of 1.4 mm near the posterior end of the strobila. Immediately behind the scolex, the proglottids are about 190μ wide. The pores are unilateral and on the right hand side of the proglottid.

The scolex is relatively inconspicuous. It is scarcely wider than the strobila immediately behind, but the suckers extend outward on each side. marking off this region from that immediately behind. Its length and width are about equal, about 175μ. The rostellum is about 75μ long when extended, and has a slightly enlarged distal portion about 70μ in diameter. It carries a crown of ten hooks, each of which is shaped as shown in figure 107. In length they measure 26μ to 31μ. When retracted the blades of the hooks are directed backward, showing that it is retracted as a solid muscular organ.

In the male reproductive system the two testes are large organs occupying the larger part of the interior of the proglottid. They are transversely placed in the posterior portion of the proglottid and somewhat toward the poral side, the ovary being slightly in the antiporal portion. The poral testis is regularly found almost directly dorsal to the longitudinal excretory ducts on that side. The nerve is found ventral to that portion of the testis, The antiporal testis reaches the excretory vessels of the antiporal side. There are two testes in each proglottid in each case observed and their position is very constant.

The cirrus sac is elongated and of about the same diameter throughout its entire length, and reaches somewhat beyond the excretory vessels on the poral side. A rounded external seminal vesicle is located at the inner end of the cirrus sac. The cirrus is large and thickly set with conspicuous spines. The internal seminal vesicle occupies the larger part of the cirrus sac. The genital ducts lie dorsal to the longitudinal excretory vessels and the pore is on the right hand side of the proglottid.

In the female reproductive system the first trace of the ovary is located on the ventral side and near the antiporal excretory vessels. As sexual development proceeds, the ovary grows laterally beneath the excretory ducts, and medially, reaching, when fully developed, to the poral excretory ducts or slightly beyond. When extending beyond the excretory vessels on the poral side, it lies dorsal to them, which is due to the ventral dis-

placement of the ducts by the cirrus sac and testis. The ovary at no time is conspicuously lobed, but in its earlier stages has a few shallow constrictions along its margin. The vitelline gland is a rounded, oval, or egg-shaped organ lying directly posterior to the ovary. The vagina is a thin-walled duct leading directly from the region of the vitelline gland to the pore. It is sometimes distended throughout almost its full length by spermatozoa, but usually only its inner end functions as a seminal receptacle.

The two layers of longitudinal muscles are well differentiated. The inner one is composed of eight large bundles, four ventral and four dorsal and placed as indicated in figure 106. The outer contains numerous much smaller bundles arranged in an almost symmetrical row in the outer portion of the proglottid.

Of the species of Diorchis which have been previously described, there are none which show much similarity either in shape of hooks or the arrangement of the internal organs. The two species which have been described from America have the testes median in position and hooks with a much longer blade in proportion to the base. The hooks of *D. americana* are about twice as long as in the above described species. In *D. acuminata*, whose hooks are about the same in length as those described above, the ovary is median, deeply lobed, and smaller, while in our species it is antiporal, transversely elongated, and scarcely lobed.

SUBFAMILY HAPLOPARAXINAE

Subfamily diagnosis: Hymenolepididae with regularly a single testis in each proglottid.

Type genus: Haploparaxis Clerc 1903.

GENUS HAPLOPARAXIS CLERC 1903

Number of testes, one. Scolex with rostellum armed with a single row of 10 to 46 hooks in the species described. Genital pores unilateral. Genital ducts pass above the excretory vessels in all the species so far mentioned except *H. furcigera* (Rud. 1819) Fuhrmann 1908, which has the genital ducts passing between the excretory vessels and ventral to the nerve, according to von Linstow (1905, figure 8, p. 23). Uterus a simple sac. In birds.

Type species: *Haploparaxis filum* (Goeze 1782) Clerc 1903.

LIST OF SPECIES

Haploparaxis australis Johnston 1911. See Johnston 1911:90
- Host: *Gallinago australis*
- Locality: Australia
- Hooks: 8, 19 to 22μ in length
- Eggs: 57 by 42μ; oncosphere 34 by 25μ

Haploparaxis brachyphallos (Krabbe 1869)
- See Krabbe 1869:310-311 (*Taenia brachyphallos*)
- Syn: *Hymenolepis brachyphallos* (Krabbe) Fuhrmann 1906
  - *Skorikowia clausa* von Linstow 1905
  - *Diorchis serpentata* von Linstow 1905
- Hooks: 10, 17 to 18μ in length

Haploparaxis cirrosa (Krabbe 1869) Clerc 1903
- See Krabbe 1869:308 (*Taenia cirrosa*); Clerc 1903:269-271.
- Hooks: 10, 24μ in length

Haploparaxis crassirostris (Krabbe 1869) Clerc 1903.
- See Krabbe 1869:314 (*Taenia crassirostris*); Clerc 1903:265-267.

Haploparaxis diminuens von Linstow 1905.
- See von Linstow 1905b:8-9.
- Hooks: 10, 14.3μ in length.

Haploparaxis dujardinii (Krabbe 1869) Clerc 1903.
- See Krabbe 1869:319-320 (*Taenia dujardinii*); Fuhrmann 1895:436 (*Taenia dujardinii*); Clerc 1903:274-275.
- Hooks: 46, 16 to 18μ in length.

Haploparaxis elisae Skrjabin 1914.
- See Skrjabin 1914:451.
- Hooks 10, 25.9μ in length.

Haploparaxis filium (Goeze 1782) Clerc 1903.
See Krabbe 1869:312-313 (*Taenia filum*); Clerc 1903:257-263.
Hooks: 10, 17μ to 18.5μ.
Haploparaxis furcigera (Rud. 1819) Fuhrmann 1908.
See Krabbe 1869:315 (*Taenia rhomboidea*);
Stiles 1896:34-35 (*Dicranotaenia furcigera*).
Hooks: 10, 47μ to 58μ in length.
Haploparaxis hirsuta (Krabbe 1882) Clerc 1902, 1903.
See Krabbe 1882:9 (*Taenia pubescens*); Clerc 1903:267-269.
Syn: *Taenia pubescens* Krabbe 1882, *Monorchis hirsuta* Clerc 1902.
Hooks: 10, 37μ to 39μ in length.
Haploparaxis larina Fuhrmann 1901.
See Fuhrmann 1901-03:518-520.
Hooks: 10, 21.6μ to 23μ in length.
Haploparaxis murmanica Baylis 1919.
See Baylis 1903:512-513.
Hooks: 10, 65μ in length.
Haploparaxis penetrans (Clerc 1902).
See Clerc 1903:271-274.
Hooks: 10, 40μ long.
Haploparaxis sphaerophora (Rud. 1810) Fuhrmann 1906.
See Fuhrmann 1906e:739.
Hapoplaraxis fuligulosa Solowiew 1911.

SPECIES INQUIRENDAE

Hymenolepis bitharzii Krabbe 1869. See Krabbe 1869:73
Hymenolepis brevicirrosa Fuhrmann 1918. See Fuhrmann 1918:402
Hymenolepis cantaniana (Polonio 1860) Ransom 1909. See Ransom 1909:36-41
Hymenolepis dahurica von Linstow 1903. See von Linstow 1903: 290.
Hymenolepis exilis (Dujardin 1845) Fuhrmann 1906. See Stiles 1896:58
Hymenolepis fusa Krabbe 1869. See Krabbe 1869:307
Hymenolepis fringillarum (Rudolphi 1809). See Krabbe 1869:326
Hymenolepis filirostris (Wedl. 1856). See Wedl. 1856:15
Hymenolepis fallax (Krabbe 1869). See Krabbe 1869:71
Hymenolepis groenlandica (Krabbe 1869). See Krabbe 1869:68
Hymenolepis liophallos (Krabbe 1869). See Krabbe 1869:43
Hymenolepis minor (Krabbe 1869) (*T. minuta*). See Krabbe 1869:292
Hymenolepis macracanthos von Linstow 1877. See Linstow 1877:16
Hymenolepis micrancristrota Wedl 1856. See Wedl 1856:6
Hymenolepis naja (Dujardin 1845). See von Linstow 1872:57.
Hymenolepis orientalis (Krabbe 1879) Fuhrmann 1906. See Krabbe 1879:11, 1882:360
Hymenolepis petrocinclae (Krabbe 1882). See Krabbe 1882:356
Hymenolepis parvirostellata von Linstow 1901. See von Linstow 1901:426.
Hymenolepis polygramma (von Linstow 1875). See von Linstow 1875:186.
Hymenolepis paculifera (von Linstow 1879). See von Linstow 1879:186.
Hymenolepis pigmentata (von Linstow 1872). Fuhrmann 1906. See von Linstow 1872:56.
Hymenolepis recurvirostrae (Krabbe 1869). See Krabbe 1869:60
Hymenolepis rosseteri Blanchard 1891. See Blanchard 1891:424-428
Hymenolepis siberica von Linstow 1905. See von Linstow 1905:6-7.
Hymenolepis spherophora (Rudolphi 1810) Fuhrmann 1906
Hymenolepis sagitta Rossetter. 1906. See Rossetter 1906:275

Hymenolepis trichorhynchus Yoshida 1910. See Yoshida 1910:241

Hymenolepis trichodroma Fuhrmann 1908. See Fuhrmann 1908:80

Hymenolepis tenerrima (von Linstow 1882). See von Linstow 1882:21.

Hymenolepis fuliginosa (Krabbe 1882). See Krabbe 1882:355

Hymenolepis vallei (Stossich 1892) Fuhrmann 1906. See Stossich 1892:68-69.

Hymenolepis megalorhyncha (Krabbe 1869). See Cohn 1901:270

Hymenolepis (*Drepanidotaenia*) *podicipina* Szymanski 1905.

See Szymanski 1904:342-344, (Fig. 1-5); 1905:733-734, (Fig. 1-5). The position of the testes in this species is described as follows: "Die drei rundlichen Hoden liegen so dass der eine nahe dem inneren Ende des Cirrusbeutels, die beiden anderen, der eine über dem anderen, an der entgegengesetzten Seite liegen (Fig. 3, 5, tes.)." This species should be restudied and the constancy of this position determined. It is probable that this characteristic position, if constant, may serve to distinguish this form as another genus distinct from those defined above.

Echinocolyle uralensis Clerc 1902.

See Clerc 1903:315-317, (Fig. 28, 32, 34, 37, and 89). The position of the testes of this species is described as follows (p. 316): "Les trois testicules sont dorsaux et disposés d'une manière particulière; les deux testicules marginaux (Pl. 9, fig. 34; Pl. 10, fig. 38) se trouvent plus en avant que le troisième qui est médian. Cette position est déjà bien accusée dans les proglottis ayant des organes femelles a peine ébauchés; elle s'accentue encore quand la vésicule séminale et le réceptacle séminal sont gonflés." The description and figures indicate that this is a very characteristic pattern of testes arrangement, but the material should be re-examined before a separate genus is defined.

The following species are closely related to *E. uralensis* in the arrangement of the testes.

Hymenolepis clausa von Linstow 1906.

See von Linstow 1906a:177-178 (Figs. 22-23)

Hymenolepis terraereginae Johnston 1911.

See Johnston 1911-89 (Figs. 25-26)

Hymenolepis fasciata (Rudolphi 1810).

See Krabbe 1869:300 (Figs. 156, 157) (*Taenia fasciata*); Stiles 1896:37-38, (Figs. 56-79) (*Drepanidotaenia fasciata*; Cohn 1901:320; Clerc 1903:307 (*Drepanidotaenia fasciata*)

XII. SUMMARY

1. A revision of the genus Hymenolepis is made on the basis of the arrangement of the testes, and a division of the species assigned to it into three genera.
2. The patterns of testes arrangement serve as reliable generic characters because:
   (a) they are invariably in the same relative positions with reference to each other in all of the proglottids of the strobila of species having a constant arrangement, and
   (b) the compound nature of the testes indicates that cestodes having the same pattern of arrangement are closely related since it is believed that in the phylogeny of the group several (two to four) testes became definitely localized in the proglottid and afterwards united, resulting in the compound testes with the different patterns of arrangements found in the present species. The evidence for the compound nature of the testes is presented under the following topics:
      (1) the irregularities in the number and branching of the vasa efferentia in five species;
      (2) the lobing of the testes;
      (3) the irregularities in the number and position of the testes in one species.
3. Fourteen new species belonging to the family are described.

NEW GENERA DESCRIBED IN THIS PAPER

NEW SPECIES DESCRIBED IN THIS PAPER

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EXPLANATION OF PLATES

All of the drawings were made with the aid of a camera lucida, and the details filled in at the same magnifications. In drawings of cross sections the excretory vessels have been indicated by heavy lines and the nerve cord filled in solid.

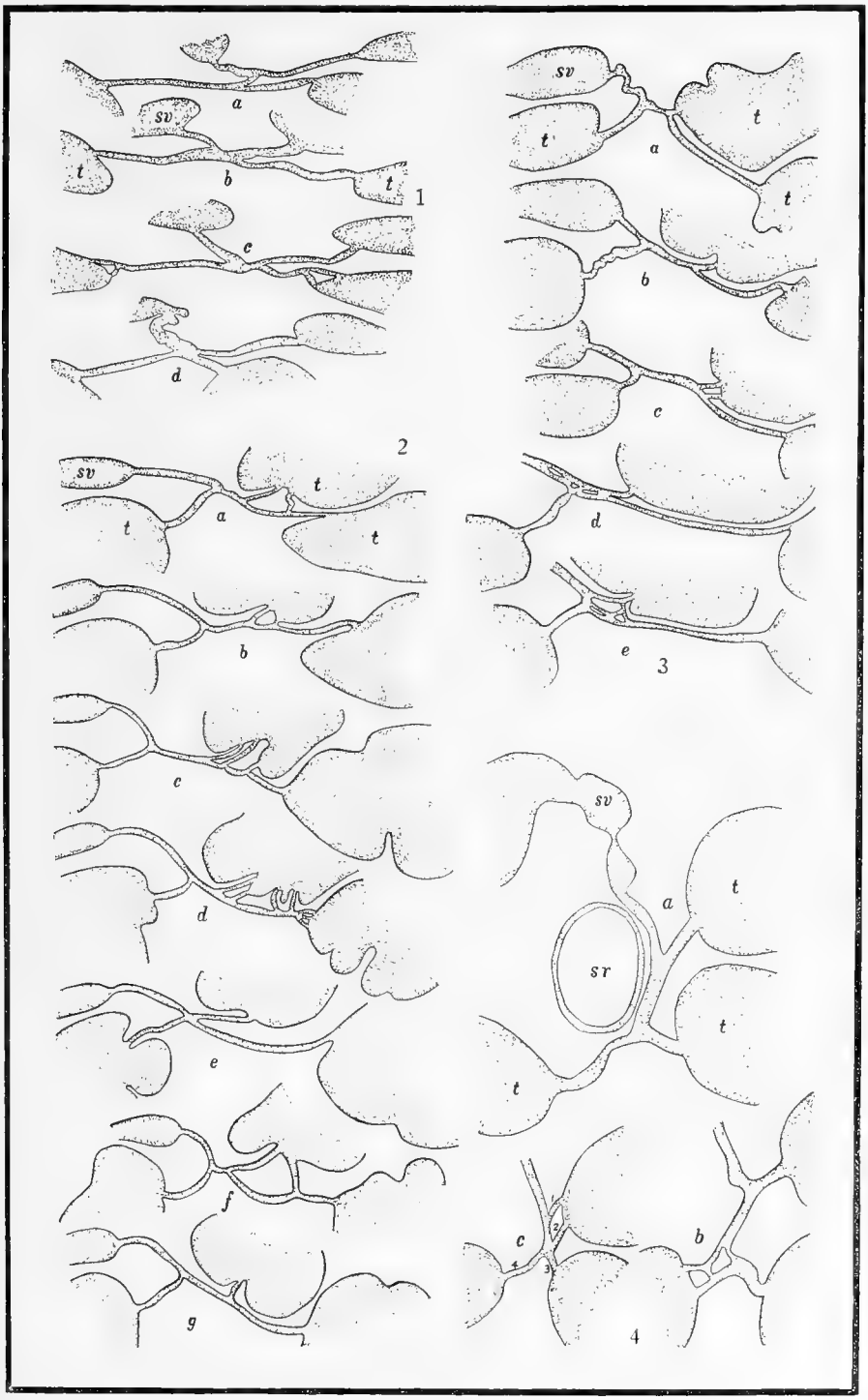
ABBREVIATIONS USED

c cirrus
cs cirrus sac
st seminal receptacle
sv external seminal vesicle
t testis
ut uterus
vag vagina

PLATE I

PLATE 1

1. *Weinlandia microcirrosa*. Vasa efferentia from four consecutive proglottids. ×48
2. *Weinlandia macrostrobilodes*, vasa efferentia from seven consecutive proglottids. ×150
3. *Weinlandia macrostrobilodes*, vasa efferentia from consecutive proglottids of another specimen than those in figure 2. ×123
4. *Weinlandia corvi*, vasa efferentia from three proglottids in the same strobila. ×333

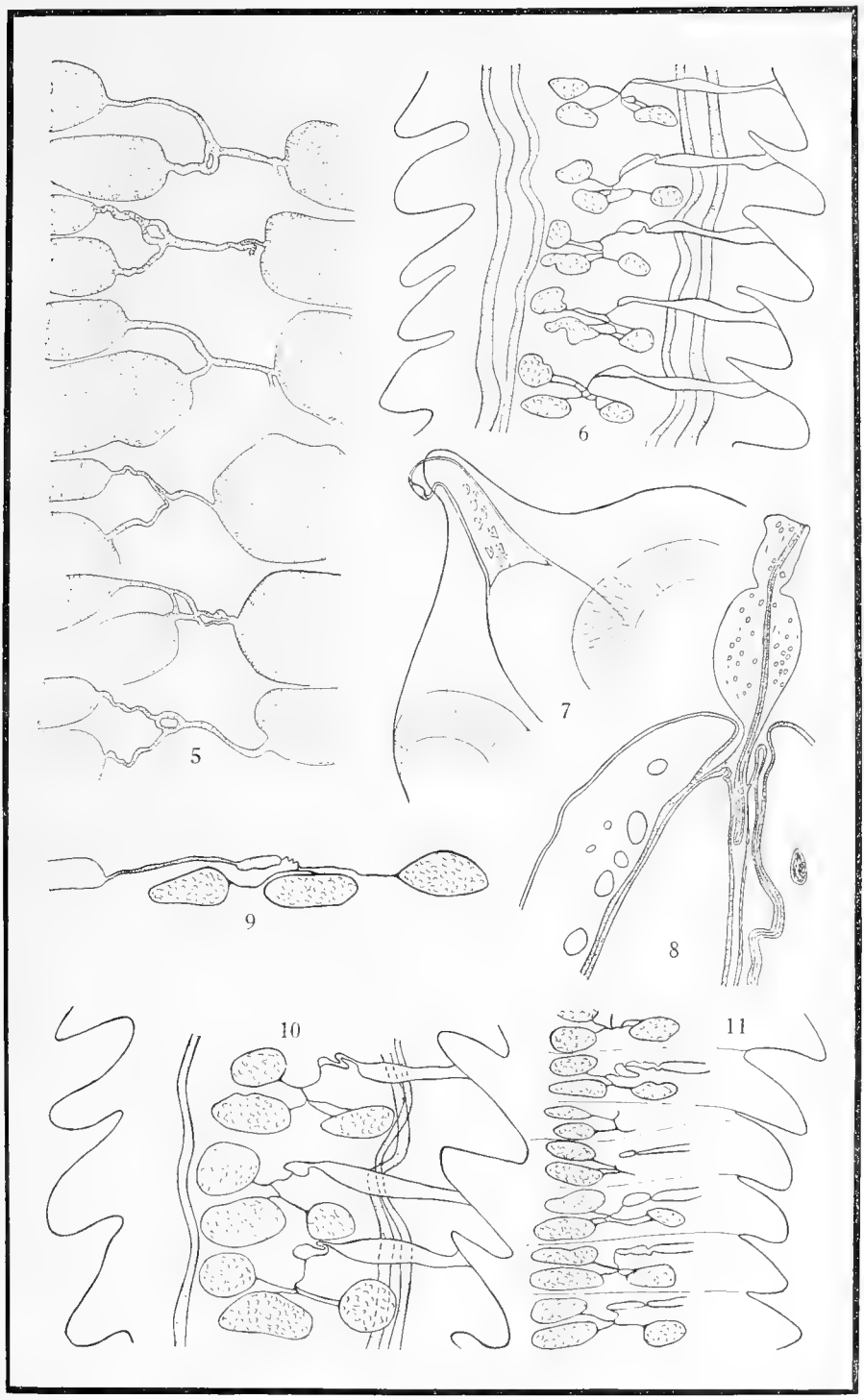


MAYHEW AVIAN HYMENOLEPIDIDAE PLATE I

PLATE II

PLATE 2

5. *Hymenolepis sacciperium*, vasa efferentia from six consecutive proglottids. ×123
6. *Weinlandia planestici*, five consecutive proglottids. ×80
7. *Hymenolepis lobulata*, retracted rostellum. ×80
8. *Wardium fryci*, extruded cirrus. ×33
9. *Hymenolepis cuneata*, testes and vasa efferentia. ×47
10. *Weinlandia planestici*, three consecutive proglottids. ×123
11. *Weinlandia planestici*, seven consecutive proglottids. ×80

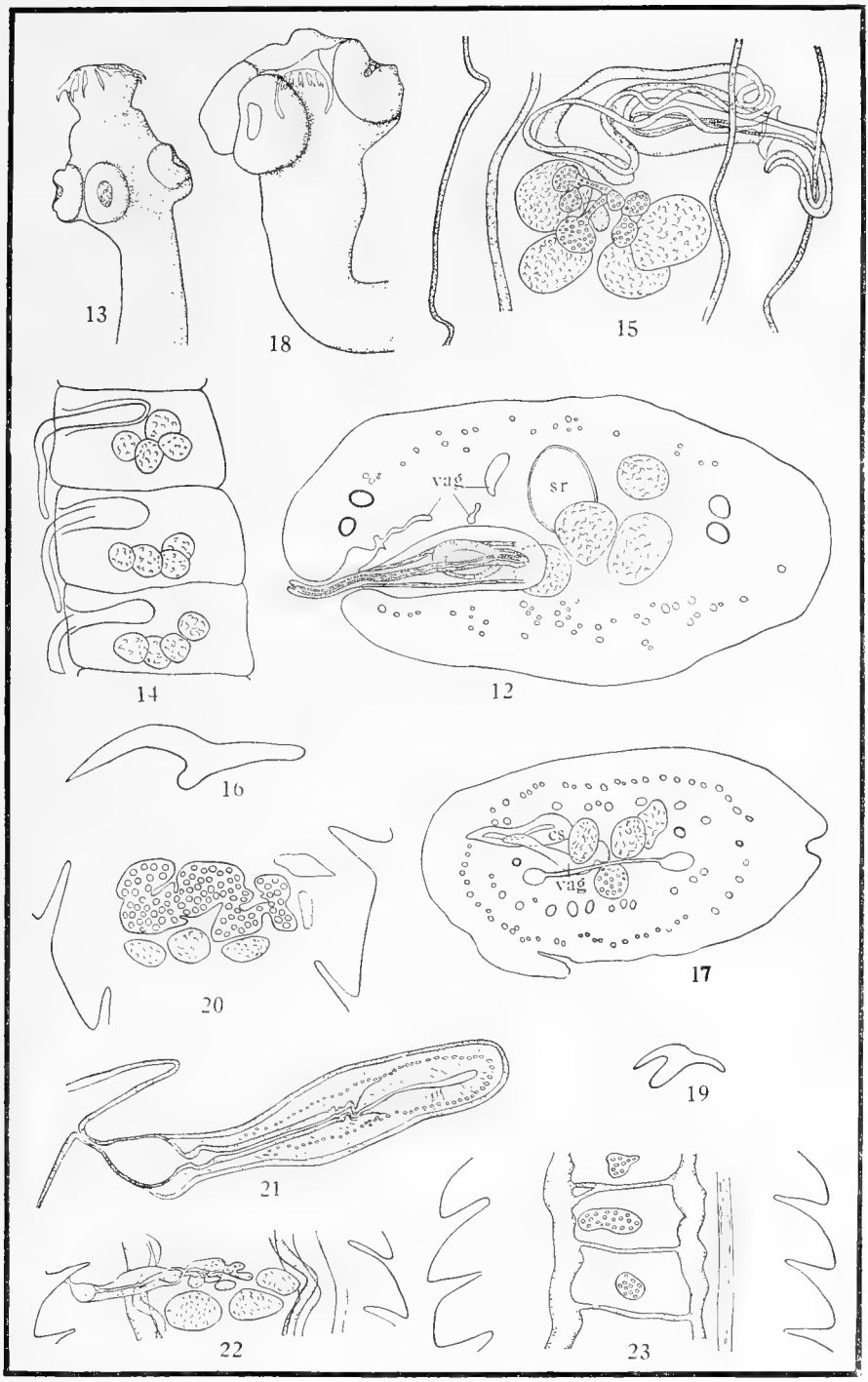


MAYHEW AVIAN HYMENOLEPIDIDAE PLATE II

PLATE III

PLATE 3

12. *Oligorchis longivaginosus*, drawing showing location of organs in transverse section. ×160
13. *Oligorchis longivaginosus*, scolex with incomplete set of hooks. ×50
14. *Oligorchis longivaginosus*, three consecutive proglottids showing variations in teste s arrangement.
15. *Oligorchis longivaginosus*, frontal view of organs from toto mount. ×80
16. *Oligorchis longivaginosus*, hook. ×355
17. *Wardium variabile*, transverse section. ×125
18. *Wardium variabile*, scolex. ×160
19. *Wardium variabile*, hook. ×600
20. *Wardium variabile*, uterus from frontal section. ×80
21. *Wardium variabile*, cirrus sac from frontal section. ×270
22. *Wardium variabile*, showing position of organs in frontal section. ×80
23. *Wardium variabile*, excretory system in frontal section. ×125

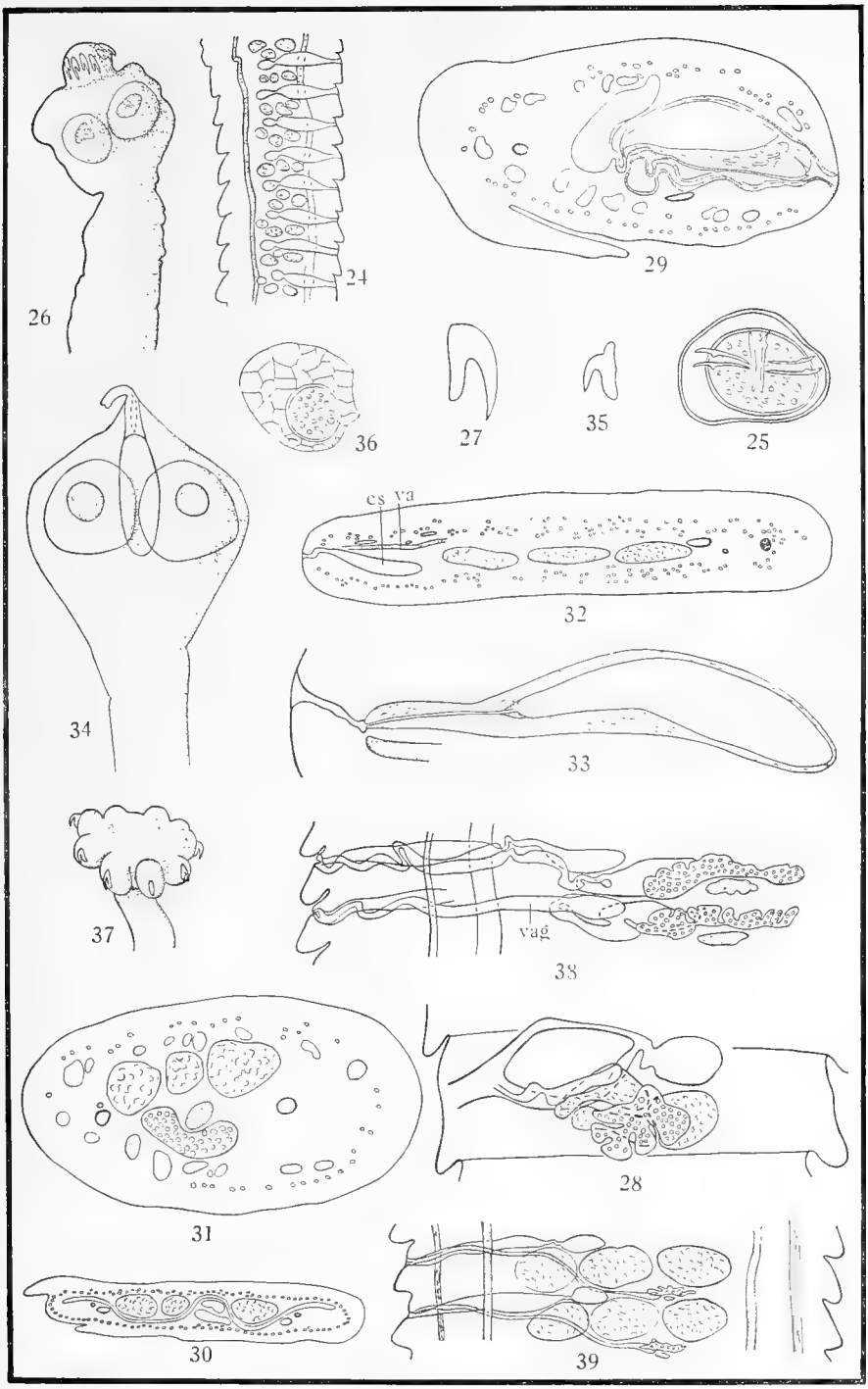


MAYHEW AVIAN HYMENOLEPIDIDAE PLATE III

PLATE IV

PLATE 4

24. *Wardium fryei*, testes arrangement in nine consecutive proglottids. ×50
25. *Wardium fryei*, egg. ×485
26. *Wardium fryei*, scolex. ×195
27. *Wardium fryei*, hook. ×750
28. *Wardium fryei*, drawing of organs from several frontal sections, ventral view. ×140
29. *Wardium fryei*, cirrus sac and vagina in transverse section. ×140
30. *Wardium fryei*, transverse section showing course of uterus. ×25
31. *Wardium fryei*, transverse section showing testes, ovary, and vitelline gland. ×140
32. *Hymenolepis lobulata*, transverse section. ×50
33. *Hymenolepis lobulata*, cirrus sac and vagina in transverse section. ×150
34. *Hymenolepis lobulata*, scolex. ×50
35. *Hymenolepis lobulata*, hook. ×450
36. *Hymenolepis lobulata*, egg. ×300
37. *Hymenolepis lobulata*, rostellum. ×160
38. *Hymenolepis lobulata* female reproductive organs from frontal section. ×10 0
39. *Hymenolepis lobulata*, male organs in frontal section. ×40

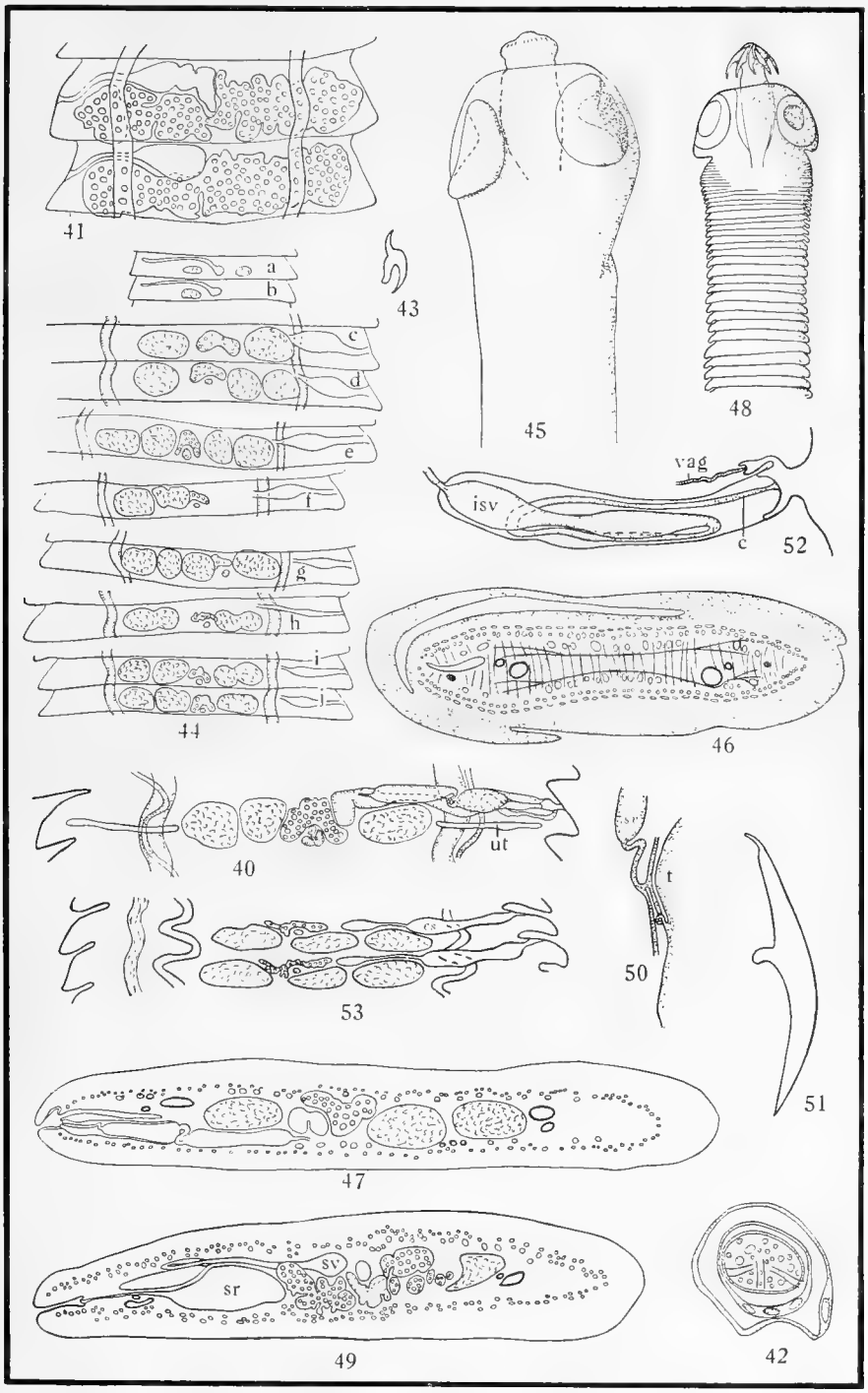


MAYHEW AVIAN HYMENOLEPIDIDAE PLATE IV

PLATE V

PLATE 5

40. *Hymenolepis sacciperium*, from frontal sections. ×40
41. *Hymenolepis sacciperium*, uterus. ×25
42. *Hymenolepis sacciperium*, egg. ×350
43. *Hymenolepis sacciperium*, hook. ×500
44. *Hymenolepis sacciperium*, a series of proglottids, a-b from one strobila, c-j from another, showing variations in the number and arrangement of the testes.
45. *Hymenolepis sacciperium*, scolex. ×125
46. *Hymenolepis sacciperium*, transverse section showing arrangement of musculature. ×50
47. *Hymenolepis sacciperium*, reproductive organs in transverse section. ×50
48. *Hymenolepis cuneata*, scolex. ×50
49. *Hymenolepis cuneata*, reproductive organs in transverse section. ×25
50. *Hymenolepis cuneata*, vasa efferentia from one proglottid in frontal section. ×155
51. *Hymenolepis cuneata*, hook. ×350
52. *Hymenolepis cuneata*, cirrus sac. ×80
53. *Hymenolepis cuneata*, from frontal sections showing position of organs. ×25

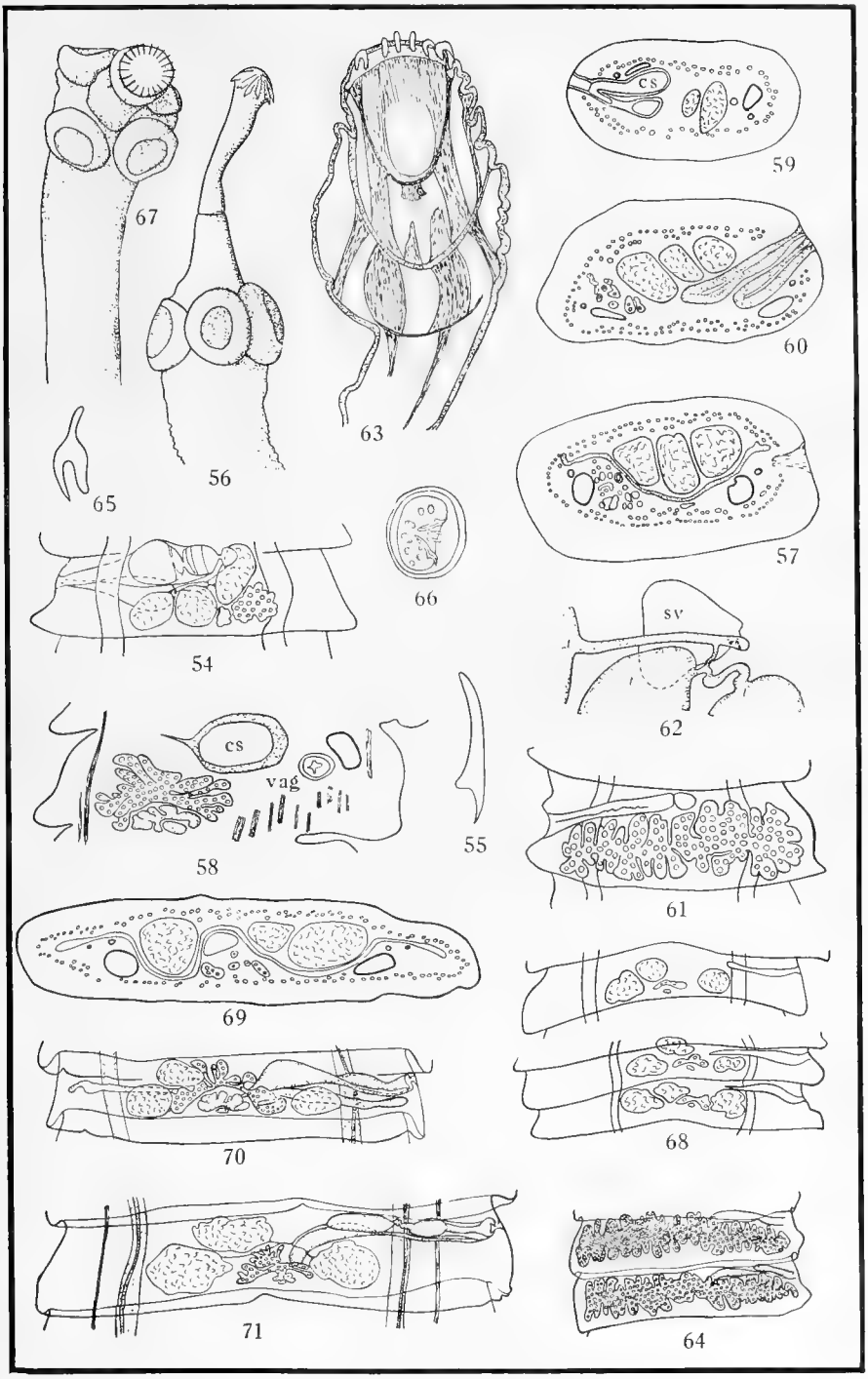


MAYHEW AVIAN HYMENOLEPIDIDAE PLATE V

PLATE VI

PLATE 6

54. *Weinlandia lateralis*, a proglottid toward the anterior end of the strobila.
55. *Weinlandia lateralis*, hook. ×730
56. *Weinlandia lateralis*, scolex. ×115
57. *Weinlandia lateralis*, transverse section of a proglottid showing course of uterus. ×50
58. *Weinlandia lateralis*, from section of proglottid farther posterior than shown in figure 54. ×50
59. *Weinlandia lateralis*, transverse section toward the anterior end of strobila. ×95
60. *Weinlandia lateralis*, transverse section farther posterior than figure 59. ×50
61. *Weinlandia lateralis*, uterus in proglottid toward posterior end of strobila. ×25
62. *Weinlandia lateralis*, vasa efferentia. ×330
63. *Weinlandia macrostrobilodes*, section of scolex showing arrangement of muscles. ×330
64. *Weinlandia macrostrobilodes*, uterus. ×15
65. *Weinlandia macrostrobilodes*, hook, ×500
66. *Weinlandia macrostrobilodes*, egg. ×330
67. *Weinlandia macrostrobilodes*, scolex. ×155
68. *Weinlandia macrostrobilodes*, proglottids from anterior end of strobila. ×25
69. *Weinlandia macrostrobilodes*, transverse section showing course of uterus. ×40.
70. *Weinlandia macrostrobilodes*, reproductive organs in toto. ×25
71. *Weinlandia macrostrobilodes*, reproductive organs in toto farther anterior than figure 70. ×40

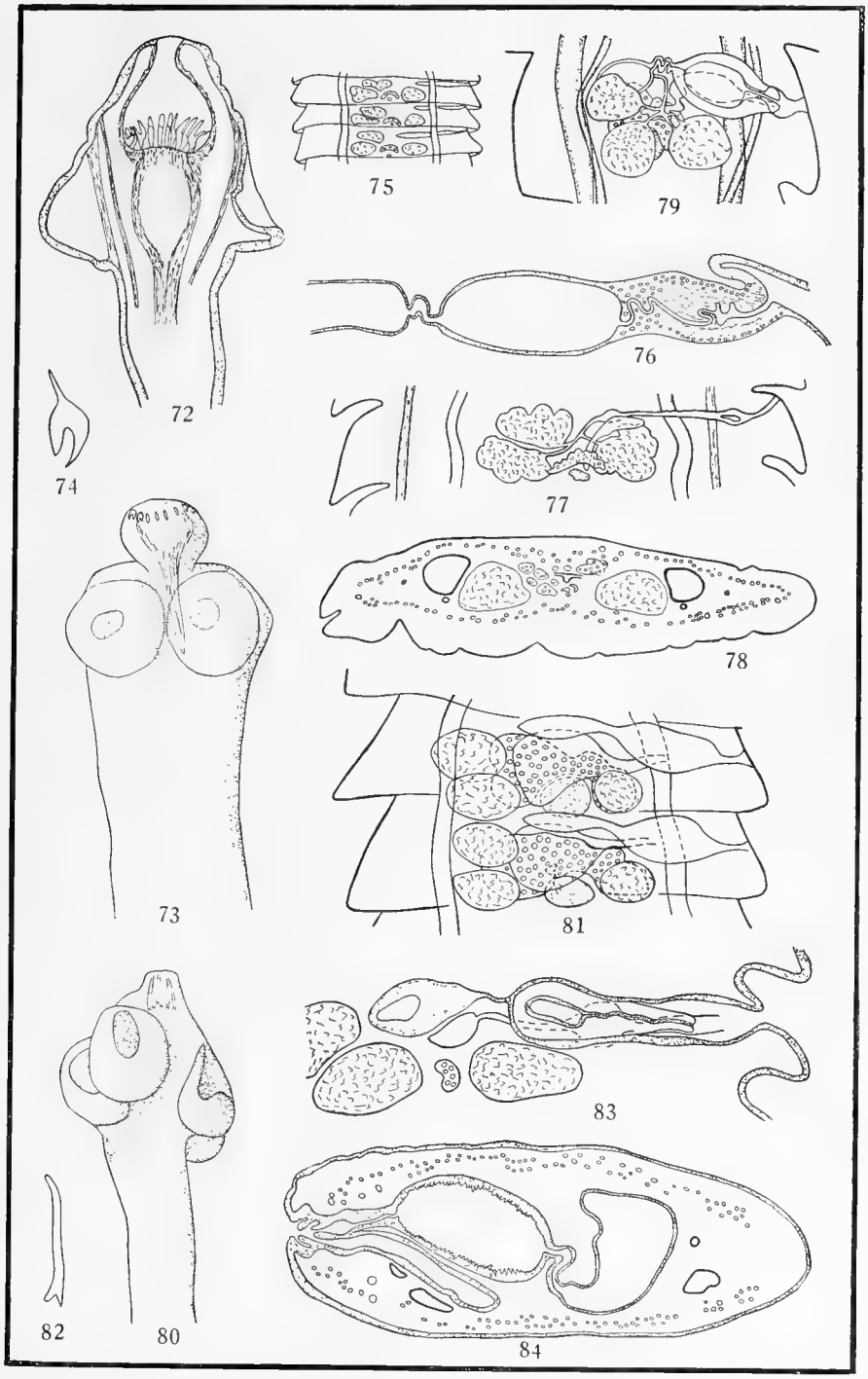


MAYHEW AVIAN HYMENOLEPIDIDAE PLATE VI

PLATE VII

PLATE 7

72. *Weinlandia introversa*, section of scolex showing arrangement of muscles. ×330
73. *Weinlandia introversa*, scolex in toto. ×160
74. *Weinlandia introversa*, hook. ×750
75. *Weinlandia introversa*, proglottids from anterior portion of strobila. ×25
76. *Weinlandia introversa*, cirrus sac. ×50
77. *Weinlandia introversa*, reproductive organs from toto mount. ×80
78. *Weinlandia macrostrobilodes*, transverse section. ×40
79. *Weinlandia corvi*, reproductive organs reconstructed from frontal sections. ×80
80. *Weinlandia corvi*, scolex. ×155
81. *Weinlandia corvi*, reproductive organs farther posterior than figure 79. ×80
82. *Weinlandia corvi*, hook. ×550
83. *Weinlandia corvi*, cirrus sac and vagina. ×175
84. *Weinlandia corvi*, transverse section. ×50

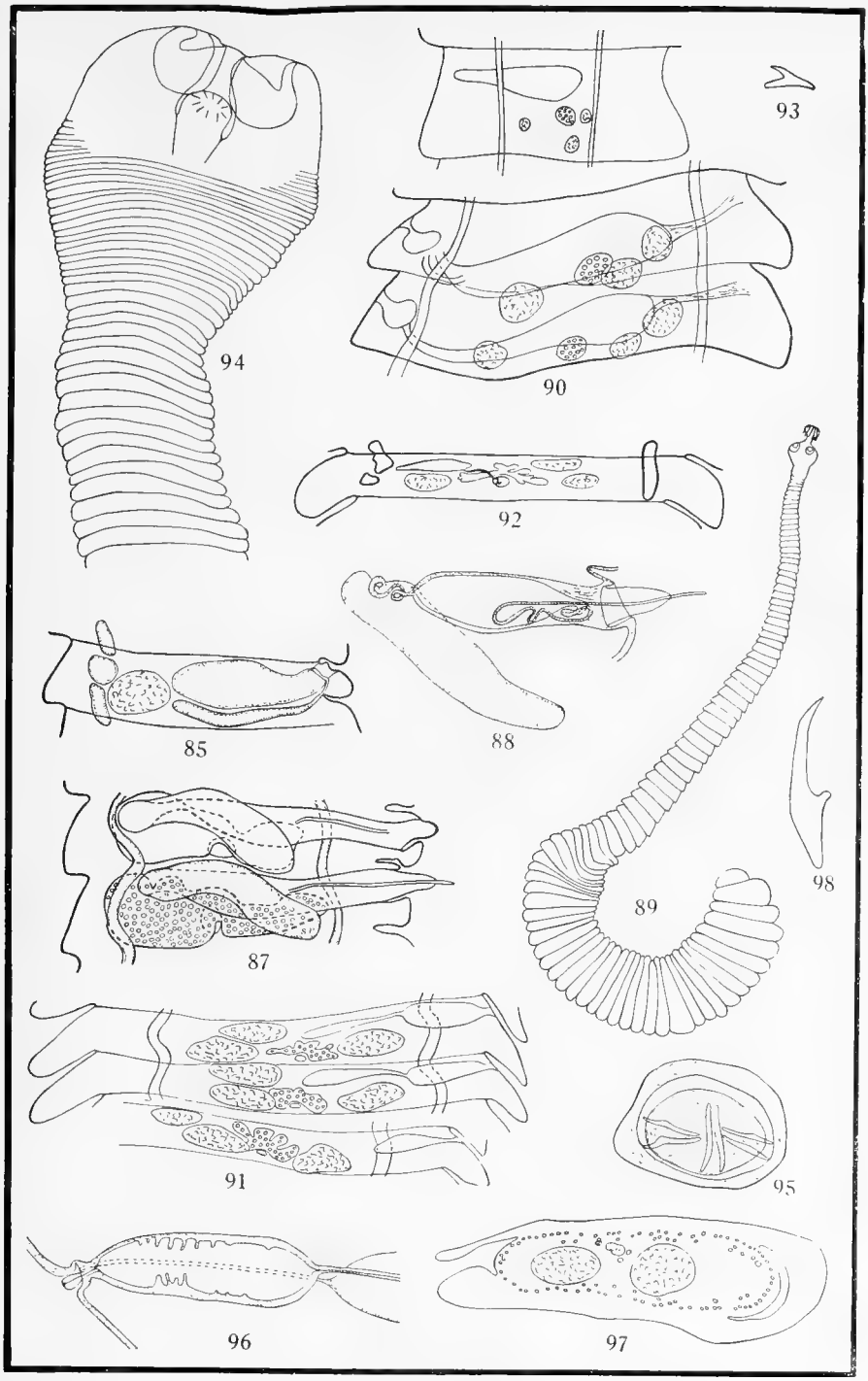


MAYHEW AVIAN HYMENOLEPIDIDAE PLATE VII

PLATE VIII

PLATE 8

85. *Weinlandia cyrtoides*, cirrus sac, vagina, one testis and exretory duct in frontal section ×125
86. *Weinlandia cyrtoides*, hook. ×330
87. *Weinlandia cyrtoides*, reproductive organs reconstructed from frontal sections. ×165
88. *Weinlandia cyrtoides*, cirrus sac and external seminal vesicle, frontal section. ×165
89. *Weinlandia cyrtoides*, outline of an entire strobila showing characteristic shape. ×25
90. *Weinlandia cyrtoides*, showing the comparative position of the cirrus sac and testes at different stages of development.
91. *Weinlandia microcirrosa*, outline of the reproductive organs in three proglottids showing variation in the position of the testes. ×45
92. *Weinlandia microcirrosa*, outline of reproductive organs at an early stage of development. ×45
93. *Weinlandia microcirrosa*, hook. ×575
94. *Weinlandia microcirrosa*, scolex. ×330
95. *Weinlandia microcirrosa*, egg. ×385
96. *Weinlandia microcirrosa*, cirrus sac. ×165
97. *Weinlandia microcirrosa*, cross section. ×54

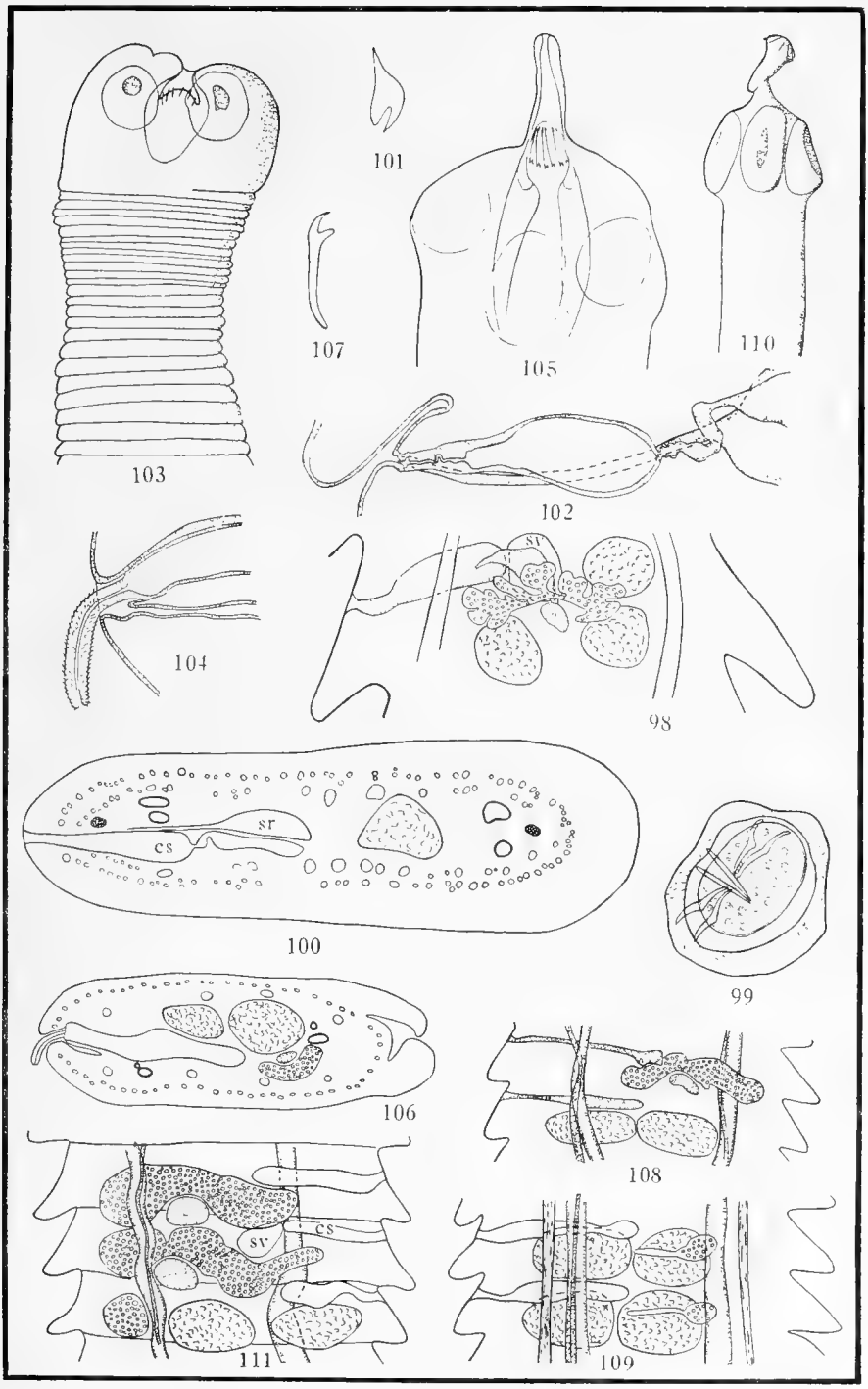


MAYHEW AVIAN HYMENOLEPIDIDAE PLATE VIII

PLATE IX

PLATE 9

98. *Weinlandia planestici*, proglottid showing reproductive organs. ×120
99. *Weinlandia planestici*, egg. ×485
100. *Weinlandia planestici*, transverse section in the region of cirrus sac. ×150
101. *Weinlandia planestici*, hook. ×700
102. *Weinlandia panestici*, cirrus sac. ×175
103. *Weinlandia planestici*, scolex. ×130
104. *Diorchis excentricus*, cirrus. ×330
105. *Diorchis excentricus*, scolex in outline showing rostellum in a retracted condition. ×190
106. *Diorchis excentricus*, transverse section. ×80
107. *Diorchis excentricus*, hook. ×500
108. *Diorchis excentricus*, two proglottids showing male and female reproductive organs. ×35
109. *Diorchis excentricus*, reproductive organs in two proglottids. ×12
110. *Diorchis excentricus*, scolex. ×80
111. *Diorchis excentricus*, male and female reproductive organs in three proglottids toward the posterior end of the strobila. ×80



MAYHEW AVIAN HYMENOLEPIDIDAE PLATE IX

INDEX OF GENERA AND SPECIES OF THE HYMENOLEPIDIDAE DISCUSSED IN THIS PAPER

The chief references to each species or genus are indicated by full face type.